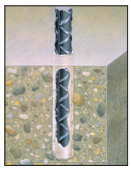
RED HEAD®

# C6+ SUBMITTAL PACKAGE

VERSATILE ADHESIVE ANCHORS FOR
CONCRETE AND MASONRY APPLICATIONS

RED HEAD®
ADHESIVE ANCHORING SPECIALISTS

# Adhesive Anchoring Selection Guide


Doweling into Concrete with Rebar

Fastening to Concrete with Threaded Rod

## Solid Concrete Applications

| PRODUCT SYSTEMS | KEY FEATURES | PROPERTIES | STRENGTH DESIGN PERFORMANCE[1] |
|---|---|---|---|

### A7+ *The Most Versatile Quick Cure*

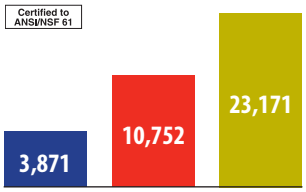
**Works in more applications than the competition**

**5 fluid oz. (150 ml) kit, 9.5 fluid oz. (280 ml) and 28 fluid oz. (825 ml) cartridges**

- The only quick-cure ICC-ES listed for use in all wet conditions
- Qualified for use in concrete, block, brick, and clay tile. Solid or hollow base materials
- Cures in only 45 minutes (at substrate temperature of 70°F/21°C)
- ICC-ES listing for cracked concrete and seismic applications (ICC-ES ESR 3903)
- ICC-ES listing for masonry applications (ICC-ES ESR 3951)
- No drip formula that allows direct-injection overhead installation
- 18 month shelf life
- NSF/ANSI 61

| BASE MATERIAL (F°/C°) | GEL/WORKING TIME | FULL CURE TIME |
|---|---|---|
| 110°/ 43° | 1.5 minutes | 45 minutes |
| 90°/ 32° | 3 minutes | 45 minutes |
| 70°/ 21° | 5 minutes | 45 minutes |
| 50°/ 10° | 15 minutes | 90 minutes |
| 30°/ -1° | 35 minutes | 4 hours |
| 14°/ -10° | 35 minutes | 24 hours |

NSF® Certified to ANSI/NSF 61




### C6+ *For the Most Demanding Jobs*

**Red Head's highest strength adhesive**

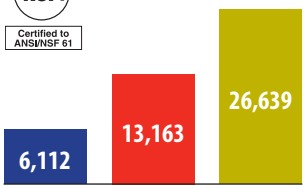
MADE IN USA WITH U.S. AND GLOBAL MATERIALS

**15.2 fluid oz. (450 ml) cartridges and 30.4 fluid oz. (900 ml) cartridges**

- At least 25% stronger than the old C6+ formulation for threaded rod in cracked concrete and with seismic conditions
- Fastest Cure time in its class, curing in just 2.75 hours at 90°F and in only 2 hours at 110°F!
- ICC-ES listing for concrete (uncracked and cracked concrete, and seismic conditions) and masonry
- ICC-ES listing for use in core-drill holes, even in cracked concrete
- Can be used in oversized holes
- Can be used in all wet conditions (saturated, water-filled, and submerged)
- European fire approval
- 24 month shelf life
- NSF/ANSI 61

| BASE MATERIAL (F°/C°) | GEL/WORKING TIME | FULL CURE TIME |
|---|---|---|
| 110°/ 43° | 10 minutes | 2 hours |
| 90°/ 32° | 14 minutes | 2.75 hours |
| 70°/ 21° | 16 minutes | 6.5 hours |
| 50°/ 13° | 30 minutes | 24 hours |
| 40°/ 7° | 46 minutes | 48 hours |

NSF® Certified to ANSI/NSF 61




### G5+ *Everyday Epoxy*

**Economical general-purpose adhesive**

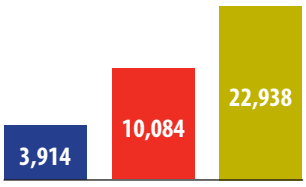
MADE IN USA WITH U.S. AND GLOBAL MATERIALS

**15.2 fluid oz. (450 ml) cartridges and 30.4 fluid oz. (900 ml) cartridges**

- At least 50% stronger than the old G5 formulation for threaded rod in cracked concrete and with seismic conditions
- Cures 3x faster than the old G5 formula
- Now works down to 40°F
- ICC-ES listing for concrete (uncracked and cracked concrete, and seismic conditions)
- Formulated for warm weather with at least 10 minutes of nozzle life
- Can be used in oversized holes
- Can be used in all wet conditions (saturated, water-filled, and submerged)
- 24 month shelf life
- NSF/ANSI 61

NSF® Certified to ANSI/NSF 61

| BASE MATERIAL (F°/C°) | GEL/WORKING TIME | FULL CURE TIME |
|---|---|---|
| 110°/ 43° | 10 minutes | 4 hours |
| 90°/ 32° | 14 minutes | 6 hours |
| 70°/ 21° | 16 minutes | 8 hours |
| 50°/ 13° | 30 minutes | 30 hours |
| 40°/ 7° | 46 minutes | 48 hours |

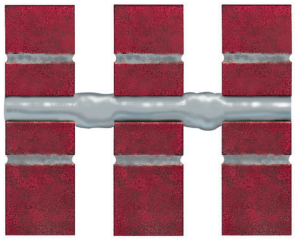



[1] Diameter x Embedment in 4000 psi concrete. All loads given in pounds. Calculated using the ICC-ES threaded rod data in uncracked, dry concrete with periodic inspection. Temperature range A.

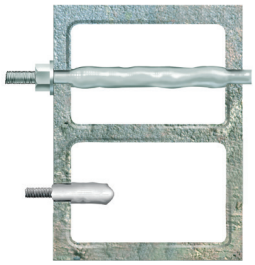
*Red head A7+ replaced Epcon A7 and S7. Red Head C6+ replaced Epcon C6+, and Red Head G5+ replaced Epcon G5. For more information on the retired adhesives (Epcon A7, S7, C6+ and G5), please visit www.itwredhead.com

# Hollow Base Material Applications

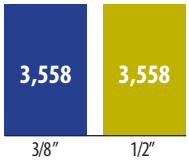
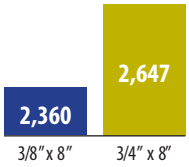
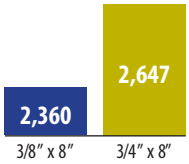
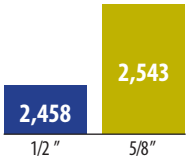
***Use the following accessories with the A7+ adhesive anchoring system for all of your hollow base material applications.***



Brick Pinning



Fastening to hollow concrete block

| SYSTEM ACCESSORIES | KEY FEATURES | ULTIMATE TENSILE [1, 2] PERFORMANCE (LBS.) |
|---|---|---|
| **Umbrella Anchor**<br> <br>Umbrella Anchor<br>**Makes it possible to use adhesive for fastening to the face of hollow block or tile** (see page 53) | ■ Highest hold in hollow block<br>■ 1/4", 3/8", or 1/2" rods<br>■ Fasten to front face of blocks<br>■ Creates large bearing surface inside block to achieve high loads | A7+<br>  <br> |
| **Nylon Screens**<br> <br>**Makes it possible to use adhesive for fastening to hollow block or brick walls** (see page 56) | ■ 3/8" to 3/4" diameter sizes<br>■ 30%-50% lower cost than stainless screens<br>■ Special design makes screens easier to insert through block or brick<br>■ Does not get bent or crushed<br>■ Corrosion resistant | A7+<br>  <br> |
| **Stainless Steel Screens**<br> <br>**Makes it possible to use adhesive for fastening to hollow block or brick walls** (see page 56) | ■ 1/4" & 3/4" diameter sizes<br>■ Corrosion resistant<br>■ Available in 1/4" thicknesses | A7+<br>  <br> |
| **Stubby Screens**<br> <br>**Makes it possible to use adhesive for fastening to the face of hollow block or tile** (see page 53) | ■ 1/4", 3/8", 1/2", 5/8" diameter sizes<br>■ Fasten to front face of block<br>■ Anchor remains perpendicular in wall | A7+<br>  <br> |

[1] Testing performed in hollow concrete block. [2] Diameter x Embedment.



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ADHESIVE ANCHORING SPECIALISTS

# C6+

## For the Most Demanding Jobs

C6P-15 C6P-30

MADE IN USA WITH U.S. AND GLOBAL MATERIALS

## DESCRIPTION

### Maximum strength epoxy for your most heavy-duty and specialty applications

Red Head C6+ is the highest strength adhesive in our history. Designed for use in the most demanding anchoring applications, the maximum strength of Red Head C6+ is backed by ICC-ES (AC308, AC58) approvals for both concrete and masonry. It is also the only adhesive approved for core-drilled holes in cracked concrete without the use of a roughening tool.

- At least 25% stronger than the old Epcon C6+ formulation for threaded rod in cracked concrete with seismic conditions
- Fastest Cure time in its class, curing in just 2.75 hours at 90°F and in only 2 hours at 110°F!
- ICC-ES listing for cracked concrete and seismic applications (ICC-ES ESR 4046)
- ICC-ES listing for masonry applications (ICC-ES ESR 4109)
- ICC-ES listing for use in core-drill holes, even in cracked concrete
- ICC-ES approved for all wet conditions (including underwater)
- Rebar fire performance report in accordance with EAD (European Assessment Document)
- At least 10 minutes of nozzle life (Even at 110F!)
- Can be used down to 40°F and up to 110°F
- Can be used in oversized holes
- Buy American Compliant. Made in USA with U.S. and Global Materials
- Rugged cartridges resist breakage due to rough handling or cold temperatures
- 24-month shelf life
- Store between 50°F and 95°F in a cool, dry place.

## ADVANTAGES

- The industry's first adhesive to be approved for use in core-drilled holes in cracked concrete without the need for a roughening tool
- Install Red Head C6+ and apply the load in the same work shift! (in 70F and above)
- Can be used in wet/damp/underwater applications
- More safe and durable on job sites than sausage packs
- Can use in both concrete and masonry substrates, including hollow and solid base materials

## Cure and Gel Times

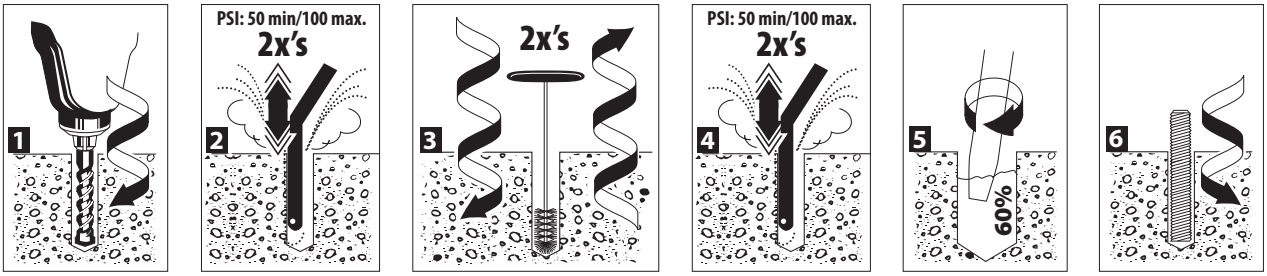
| BASE MATERIAL (F°/C°) | GEL TIME[2] | FULL CURE TIME |
|---|---|---|
| 110°/ 43° | 10 minutes | 2 hours |
| 90°/ 32° | 14 minutes | 2.75 hours |
| 70°/ 21° | 16 minutes | 6.5 hours |
| 50°/ 10° | 30 minutes | 24 hours |
| 40°/ 4.4° | 46 minutes | 48 hours |

1 For concrete temperatures between 40-50°F adhesive must be maintained at a minimum of 50°F during installation.
2 Gel time is max time from the end of mixing to when the insertion of the threaded rod or rebar into the adhesive shall be completed.

# C6+

## INSTALLATION STEPS *for Carbide-Tipped Bits*

**DRILL** **BLOW**** **BRUSH** **BLOW**** **DISPENSE** **INSTALL**

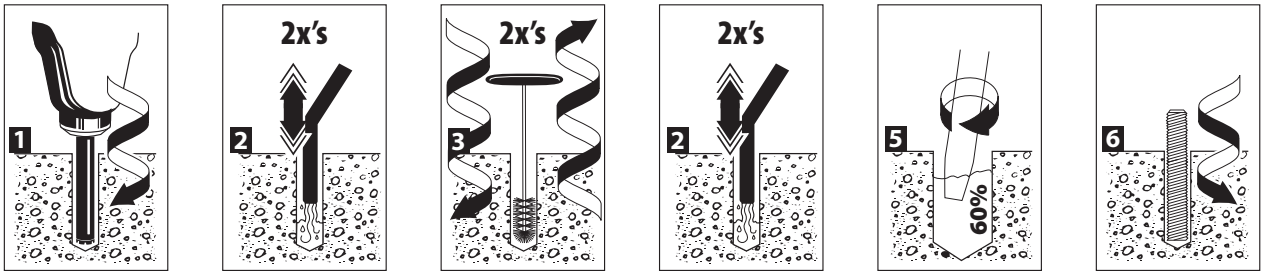



* Damp, submerged and underwater applications require 4x's air, 4x's brushing and 4x's air

** Dust is shown for diagram purposes only. To help mitigate airborne dust and comply with OSHA requirements, we recommend that you either wet the concrete before blowing out the hole, or use a drill dust extractor with your pneumatic air nozzle. We recommend vacuum assisted dust extractors like Milwaukee part numbers 5261-DE or 5317-DE. Call our technical services at (800) 848-5611 for more information."

## INSTALLATION STEPS *for Core-Drilled Holes*

**DRILL** **BLOW** **BRUSH** **BLOW** **DISPENSE** **INSTALL**




Flush with water

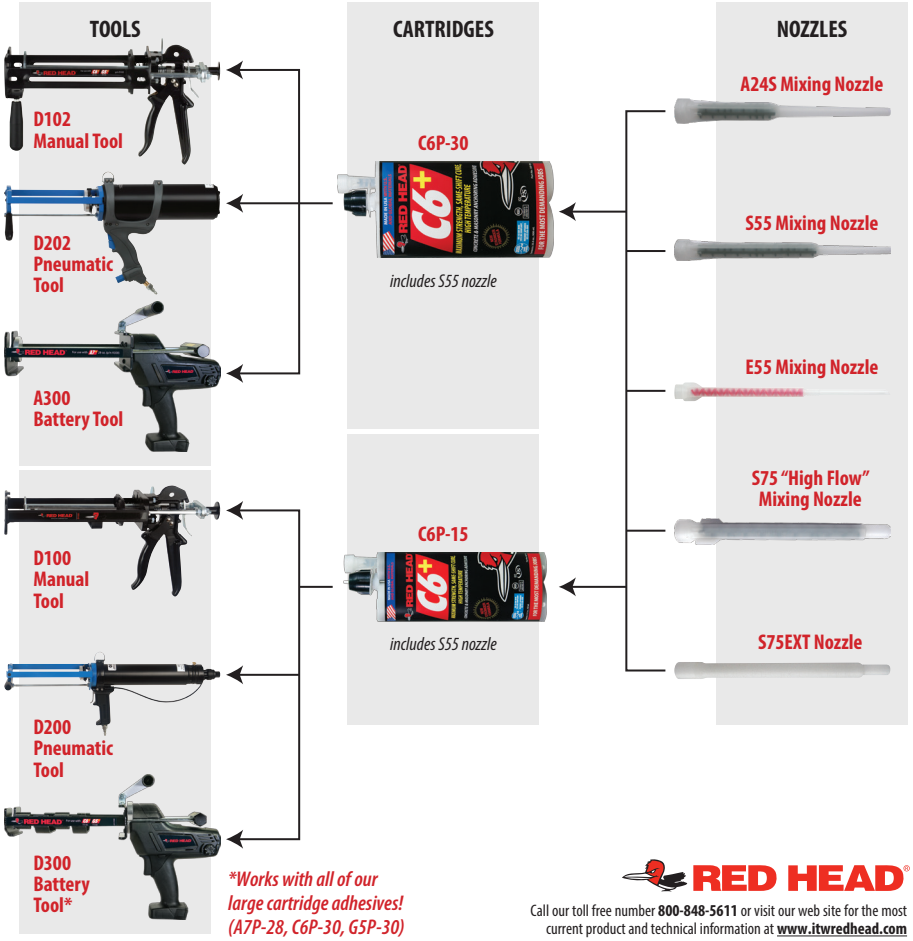
Flush with water & remove any standing water

## APPROVALS/LISTINGS

- ICC-ES ESR 4046 (Concrete Report)
- ICC-ES ESR 4109 (Masonry Report)
- 2015, 2012, 2009, 2006 International Building Code (IBC) Compliant
- Florida Building Code (FBC)
- City of Los Angeles (COLA)
- Department of Transportation (DOT) Listings
- NSF/ANSI 61 Approval for use in Drinking Water System Components
- ASTM C881, Types I, II, IV, and V, Grade 3, Classes B & C
- Rebar fire performance report in accordance with EAD (European Assessment Document)

**For the most current approvals/listings visit: www.ITW-RedHead.com**

## *Selection Guide*




**Works with all of our large cartridge adhesives! (A7P-28, C6P-30, G5P-30)*



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# C6P–30.4 fl. oz. Ordering Information

| PART NUMBER | DESCRIPTION | BOX QTY |
|---|---|---|
| C6P-30 | 30.4 Fluid Ounce Red Head C6+ Cartridge with S55 Nozzle | 4 |
| D102 | Heavy-Duty 34:1 thrust ratio hand dispenser for C6P-30 and G5P-30 cartridges | 1 |
| S55 | Standard Mixing Nozzle, fits holes for 3/8″ diameter anchors and larger. 3-1/2″ inch usable length for 3/8″ and 1/2″ anchors, 8-1/4″ usable length for 5/8″ anchors and above | 24 |
| E55 | Long Mixing Nozzle, fits holes for 3/8″ diameter anchors and larger. 5-3/4″ inch usable length for 3/8″ and ½″ anchors, 12-5/8″ usable length for 5/8″ anchors and above | 24 |

| PART NUMBER | DESCRIPTION | BOX QTY |
|---|---|---|
| D202 | Pneumatic Dispenser for C6P-30 and G5P-30 cartridges | 1 |
| A300 | Cordless Battery Dispenser for A7P-28, C6P-30 and G5P-30 Cartridge. Includes one battery and charger. Works with all Milwaukee® M18™ batteries (Contact Milwaukee® for more information on batteries) | 1 |
| S75 | High Flow Mixing Nozzle, fits holes for ¾″ diameter anchors and larger. 7-3/8″ usable length | 24 |
|  S75EXT | Extension for High Flow Mixing Nozzle for ¾″ diameter anchors and larger. 15-5/8″ usable length when attached to S75 | 24 |

*See page 65 for nozzle extension tubes and other accessories

## ESTIMATING TABLES

### C6P-30 30.4 Fluid Ounce Cartridge

### Number of Anchoring Installations Per Cartridge* Using Threaded Rod or Rebar with C6+ Adhesive in Solid Concrete

| ANCHOR DIA. | | DRILL HOLE DIA. | NUMBER OF ANCHORING INSTALLATIONS PER CARTRIDGE* USING THREADED ROD OR REBAR WITH C6+ ADHESIVE IN SOLID CONCRETE | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| in. | # rebar | (in.) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| 3/8 | #3 | 7/16 | 608.9 | 304.5 | 203.0 | 152.2 | 121.8 | 101.5 | 87.0 | 76.1 | 67.7 | 60.9 | 55.4 | 50.7 | 46.8 | 43.5 | 40.6 |
| 1/2 | | 9/16 | 368.3 | 184.2 | 122.8 | 92.1 | 73.7 | 61.4 | 52.6 | 46.0 | 40.9 | 36.8 | 33.5 | 30.7 | 28.3 | 26.3 | 24.6 |
| | #4 | 5/8 | 298.4 | 149.2 | 99.5 | 74.6 | 59.7 | 49.7 | 42.6 | 37.3 | 33.2 | 29.8 | 27.1 | 24.9 | 23.0 | 21.3 | 19.9 |
| 5/8 | #5 | 3/4 | 207.2 | 103.6 | 69.1 | 51.8 | 41.4 | 34.5 | 29.6 | 25.9 | 23.0 | 20.7 | 18.8 | 17.3 | 15.9 | 14.8 | 13.8 |
| 3/4 | #6 | 7/8 | 152.2 | 76.1 | 50.7 | 38.1 | 30.4 | 25.4 | 21.7 | 19.0 | 16.9 | 15.2 | 13.8 | 12.7 | 11.7 | 10.9 | 10.1 |
| 7/8 | #7 | 1 | 116.5 | 58.3 | 38.8 | 29.1 | 23.3 | 19.4 | 16.6 | 14.6 | 12.9 | 11.7 | 10.6 | 9.7 | 9.0 | 8.3 | 7.8 |
| 1 | #8 | 1-1/8 | 92.1 | 46.0 | 30.7 | 23.0 | 18.4 | 15.3 | 13.2 | 11.5 | 10.2 | 9.2 | 8.4 | 7.7 | 7.1 | 6.6 | 6.1 |
| | #9 | 1-1/4 | 74.6 | 37.3 | 24.9 | 18.6 | 14.9 | 12.4 | 10.7 | 9.3 | 8.3 | 7.5 | 6.8 | 6.2 | 5.7 | 5.3 | 5.0 |
| 1-1/4 | | 1-3/8 | 61.6 | 30.8 | 20.5 | 15.4 | 12.3 | 10.3 | 8.8 | 7.7 | 6.8 | 6.2 | 5.6 | 5.1 | 4.7 | 4.4 | 4.1 |
| | #10 | 1-1/2 | 51.8 | 25.9 | 17.3 | 12.9 | 10.4 | 8.6 | 7.4 | 6.5 | 5.8 | 5.2 | 4.7 | 4.3 | 4.0 | 3.7 | 3.5 |
| 1-1/2" | | 1-5/8" | 44.1 | 22.1 | 14.7 | 11.0 | 8.8 | 7.4 | 6.3 | 5.5 | 4.9 | 4.4 | 4.0 | 3.7 | 3.4 | 3.2 | 2.9 |
| | #11 | 1-3/4 | 38.1 | 19.0 | 12.7 | 9.5 | 7.6 | 6.3 | 5.4 | 4.8 | 4.2 | 3.8 | 3.5 | 3.2 | 2.9 | 2.7 | 2.5 |

*The estimated number of anchoring installations per cartridge is based upon calculations of filling the hole 60% full of adhesive per the recommendation in our installation instructions. Hole volumes are calculated using ANSI tolerance carbide tipped drill bits. These estimates do not account for any waste.

# C6P–15 fl. oz. Ordering Information

| PART NUMBER | DESCRIPTION | BOX QTY |
|---|---|---|
| C6P-15 | 15.2 Fluid Ounce Red Head C6+ Cartridge with S55 Nozzle | 4 |
| D100 | Heavy-Duty 34:1 thrust ratio hand dispenser for C6P-15 and G5P-15 cartridges | 1 |
| S55 | Standard Mixing Nozzle, fits holes for 3/8″ diameter anchors and larger. 3-1/2″ inch usable length for 3/8″ and 1/2″ anchors, 8-1/4″ usable length for 5/8″ anchors and above | 24 |
| E55 | Long Mixing Nozzle, fits holes for 3/8″ diameter anchors and larger. 5-3/4″ inch usable length for 3/8″ and ½″ anchors, 12-5/8″ usable length for 5/8″ anchors and above | 24 |

| PART NUMBER | DESCRIPTION | BOX QTY |
|---|---|---|
| D200 | Ergonomic Pneumatic Dispenser for C6P-15 and G5P-15 cartridges | 1 |
| D300 | Cordless Battery Dispenser for C6P-15 and G5P-15 Cartridge. Includes one battery and charger. Works with all Milwaukee® M18™ batteries | 1 |
| S75 | High Flow Mixing Nozzle, fits holes for ¾″ diameter anchors and larger. 7-3/8″ usable length | 24 |
|  S75EXT | Extension for High Flow Mixing Nozzle for ¾″ diameter anchors and larger. 15-5/8″ usable length when attached to S75 | 24 |

*See page 65 for nozzle extension tubes and other accessories

## ESTIMATING TABLES

### C6P-15 15.2 Fluid Ounce Cartridge

### Number of Anchoring Installations Per Cartridge* Using Threaded Rod or Rebar with C6+ Adhesive in Solid Concrete

| ANCHOR DIA. in. | ANCHOR DIA. # rebar | DRILL HOLE DIA. (in.) | EMBEDMENT DEPTH IN INCHES 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3/8 | #3 | 7/16 | 304.5 | 152.2 | 101.5 | 76.1 | 60.9 | 50.7 | 43.5 | 38.1 | 33.8 | 30.4 | 27.7 | 25.4 | 23.4 | 21.7 | 20.3 |
| 1/2 | | 9/16 | 184.2 | 92.1 | 61.4 | 46.0 | 36.8 | 30.7 | 26.3 | 23.0 | 20.5 | 18.4 | 16.7 | 15.3 | 14.2 | 13.2 | 12.3 |
| | #4 | 5/8 | 149.2 | 74.6 | 49.7 | 37.3 | 29.8 | 24.9 | 21.3 | 18.6 | 16.6 | 14.9 | 13.6 | 12.4 | 11.5 | 10.7 | 9.9 |
| 5/8 | #5 | 3/4 | 103.6 | 51.8 | 34.5 | 25.9 | 20.7 | 17.3 | 14.8 | 12.9 | 11.5 | 10.4 | 9.4 | 8.6 | 8.0 | 7.4 | 6.9 |
| 3/4 | #6 | 7/8 | 76.1 | 38.1 | 25.4 | 19.0 | 15.2 | 12.7 | 10.9 | 9.5 | 8.5 | 7.6 | 6.9 | 6.3 | 5.9 | 5.4 | 5.1 |
| 7/8 | #7 | 1 | 58.3 | 29.1 | 19.4 | 14.6 | 11.7 | 9.7 | 8.3 | 7.3 | 6.5 | 5.8 | 5.3 | 4.9 | 4.5 | 4.2 | 3.9 |
| 1 | #8 | 1-1/8 | 46.0 | 23.0 | 15.3 | 11.5 | 9.2 | 7.7 | 6.6 | 5.8 | 5.1 | 4.6 | 4.2 | 3.8 | 3.5 | 3.3 | 3.1 |
| | #9 | 1-1/4 | 37.3 | 18.6 | 12.4 | 9.3 | 7.5 | 6.2 | 5.3 | 4.7 | 4.1 | 3.7 | 3.4 | 3.1 | 2.9 | 2.7 | 2.5 |
| 1-1/4 | | 1-3/8 | 30.8 | 15.4 | 10.3 | 7.7 | 6.2 | 5.1 | 4.4 | 3.9 | 3.4 | 3.1 | 2.8 | 2.6 | 2.4 | 2.2 | 2.1 |
| | #10 | 1-1/2 | 25.9 | 12.9 | 8.6 | 6.5 | 5.2 | 4.3 | 3.7 | 3.2 | 2.9 | 2.6 | 2.4 | 2.2 | 2.0 | 1.8 | 1.7 |
| 1-1/2" | | 1-5/8" | 22.1 | 11.0 | 7.4 | 5.5 | 4.4 | 3.7 | 3.2 | 2.8 | 2.5 | 2.2 | 2.0 | 1.8 | 1.7 | 1.6 | 1.5 |
| | #11 | 1-3/4 | 19.0 | 9.5 | 6.3 | 4.8 | 3.8 | 3.2 | 2.7 | 2.4 | 2.1 | 1.9 | 1.7 | 1.6 | 1.5 | 1.4 | 1.3 |

*The estimated number of anchoring installations per cartridge is based upon calculations of filling the hole 60% full of adhesive per the recommendation in our installation instructions. Hole volumes are calculated using ANSI tolerance carbide tipped drill bits. These estimates do not account for any waste.



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## ALLOWABLE STRESS DESIGN

### C6+ For the Most Demanding Jobs

### Average Ultimate Tension and Shear Loads[1,2,3] for Threaded Rod Installed in Solid Concrete

| THREADED ROD DIA. (in.) | EMBEDMENT IN CONCRETE (in.) | MAX. CLAMPING FORCE AFTER PROPER CURE ft./lbs. | ULTIMATE TENSION (lbs.) | | | ULTIMATE SHEAR (lbs.) |
|---|---|---|---|---|---|---|
| | | | 3,000 PSI CONCRETE | 5,000 PSI CONCRETE | 7,000 PSI CONCRETE | 3,000 PSI CONCRETE & HIGHER |
| 3/8 | 1-1/2 | 9 | 3,160 | 3,785 | 4,405 | N/A |
| | 3-3/8 | | 11,640 | 12,315 | 12,985 | 5,200 |
| 1/2 | 2 | 16 | 6,075 | 7,015 | 7,950 | N/A |
| | 4-1/2 | | 20,005 | 23,305 | 26,605 | 11,420 |
| 5/8 | 2-1/2 | 47 | 8,570 | 9,995 | 11,420 | N/A |
| | 5-5/8 | | 24,905 | 29,015 | 33,125 | 18,300 |
| 3/4 | 3 | 70 | 12,030 | 13,570 | 15,105 | N/A |
| | 6-3/4 | | 36,645 | 42,695 | 48,740 | 25,720 |
| 7/8 | 3-1/2 | 90 | 15,005 | 17,335 | 19,660 | N/A |
| | 7-7/8 | | 55,575 | 70,338 | 85,100 | 32,120 |
| 1 | 4 | 110 | 17,735 | 20,390 | 23,045 | N/A |
| | 9 | | 62,250 | 73,850 | 85,450 | 38,520 |
| 1-1/4 | 5 | 370 | 34,695 | 36,935 | 39,170 | N/A |
| | 11-1/4 | | 77,815 | 90,655 | 103,495 | 65,080 |
| 1-1/2 | 13 | 450 | 101,085 | 117,765 | 134,445 | N/A |

1. Allowable working loads for the single installations under static loading should not exceed 25% capacity of the ultimate load (to get the allowable load of the anchor rod, divide the ultimate load by 4).
2. Performance values are based on the use of high strength threaded rod (ASTM A193 Gr. B7). The use of lower strength rods will result in lower ultimate tension and shear loads.
3. Linear interpolation may be used for intermediate spacing and edge distances.

## ALLOWABLE STRESS DESIGN

### C6+ For the Most Demanding Jobs

### Allowable Tension Loads[1] for Threaded Rod Installed In Solid Concrete

| THREADED ROD DIA in. | EMBEDMENT IN CONCRETE in. | ALLOWABLE TENSION LOAD BASED ON CONCRETE STRENGTH (lbs.) | | | ALLOWABLE TENSION LOAD BASED ON STEEL STRENGTH (lbs.) | | |
|---|---|---|---|---|---|---|---|
| | | 3,000 psi concrete | 5,000 psi concrete | 7,000 psi concrete | ASTM A307 | ASTM A193 GRADE B7 | ASTM F593 AISI 304 SS |
| 3/8 | 1-1/2 | 790 | 945 | 1,100 | 2,080 | 4,340 | 3,995 |
| | 3-3/8 | 2,910 | 3,080 | 3,245 | 2,080 | 4,340 | 3,995 |
| 1/2 | 2 | 1,520 | 1,755 | 1,990 | 3,730 | 7,780 | 7,155 |
| | 4-1/2 | 5,000 | 5,825 | 6,650 | 3,730 | 7,780 | 7,155 |
| 5/8 | 2-1/2 | 2,145 | 2,500 | 2,855 | 5,870 | 12,230 | 11,250 |
| | 5-5/8 | 6,225 | 7,255 | 8,280 | 5,870 | 12,230 | 11,250 |
| 3/4 | 3 | 3,010 | 3,395 | 3,775 | 8,490 | 17,690 | 14,860 |
| | 6-3/4 | 9,160 | 10,675 | 12,185 | 8,490 | 17,690 | 14,860 |
| 7/8 | 3-1/2 | 3,750 | 4,335 | 4,915 | 11,600 | 25,510 | 20,835 |
| | 7-7/8 | 13,895 | 17,585 | 21,275 | 11,600 | 25,510 | 20,835 |
| 1 | 4 | 4,435 | 5,100 | 5,760 | 15,180 | 31,620 | 26,560 |
| | 9 | 15,565 | 18,465 | 21,365 | 15,180 | 31,620 | 26,560 |
| 1-1/4 | 5 | 8,675 | 9,235 | 9,795 | 23,800 | 49,580 | 34,670 |
| | 11-1/4 | 19,455 | 22,665 | 25,875 | 23,800 | 49,580 | 34,670 |
| 1-1/2 | 13 | 25,270 | 29,440 | 33,610 | 33,720 | 70,250 | 47,770 |

1. Use lower value of either bond or steel strength for allowable tension load.

## ALLOWABLE STRESS DESIGN

**C6+ For the Most Demanding Jobs**

### Allowable Shear Loads[1] for Threaded Rod Installed in Solid Concrete

| THREADED ROD DIA. (in.) | EMBEDMENT IN CONCRETE (in.) | ALLOWABLE SHEAR LOAD BASED ON CONCRETE STRENGTH (lbs.) | ALLOWABLE SHEAR LOAD BASED ON STEEL STRENGTH (lbs.) | | |
|---|---|---|---|---|---|
| | | 3,000 psi concrete & higher | ASTM A307 | ASTM A193 GRADE B7 | ASTM F593 AISI 304 SS |
| 3/8 | 1-1/2<br>3-3/8 | N/A<br>1,300 | 1,040<br>1,040 | 2,170<br>2,170 | 1,995<br>1,995 |
| 1/2 | 2<br>4-1/2 | N/A<br>2,855 | 1,870<br>1,870 | 3,895<br>3,895 | 3,585<br>3,585 |
| 5/8 | 2-1/2<br>5-5/8 | N/A<br>4,575 | 2,940<br>2,940 | 6,125<br>6,125 | 5,635<br>5,635 |
| 3/4 | 3<br>6-3/4 | N/A<br>6,430 | 4,250<br>4,250 | 8,855<br>8,855 | 7,440<br>7,440 |
| 7/8 | 3-1/2<br>7-7/8 | N/A<br>8,030 | 5,800<br>5,800 | 12,760<br>12,760 | 10,730<br>10,730 |
| 1 | 4<br>9 | N/A<br>9,630 | 7,590<br>7,590 | 15,810<br>15,810 | 13,285<br>13,285 |
| 1-1/4 | 5<br>11-1/4 | N/A<br>16,270 | 11,900<br>11,900 | 24,790<br>24,790 | 18,840<br>18,840 |

1. Use lower value of either concrete or steel strength for allowable shear load.

## ALLOWABLE STRESS DESIGN

**C6+ For the Most Demanding Jobs**

### Average Ultimate Tension Loads[1,2,3] for Reinforcing Bar Installed In Solid Concrete

| REINFORCING BAR | EMBEDMENT IN CONCRETE (in.) | ULTIMATE TENSION (lbs.) | | | ULTIMATE YIELD STRENGTH GRADE 60 REBAR (lbs.) | ULTIMATE TENSILE STRENGTH GRADE 60 REBAR (lbs.) |
|---|---|---|---|---|---|---|
| | | 3,000 psi concrete | 5,000 psi concrete | 7,000 psi concrete | | |
| #3 | 1-1/2 | 3,160 | 3,785 | 4,405 | 6,600 | 9,900 |
| | 3-3/8 | 11,640 | 12,315 | 12,985 | | |
| #4 | 2 | 6,075 | 7,015 | 7,950 | 12,000 | 18,000 |
| | 4-1/2 | 20,005 | 23,305 | 26,605 | | |
| #5 | 2-1/2 | 8,570 | 9,995 | 11,420 | 18,600 | 27,900 |
| | 5-5/8 | 24,905 | 29,015 | 33,125 | | |
| #6 | 3 | 12,030 | 13,570 | 15,105 | 26,400 | 39,600 |
| | 6-3/4 | 36,645 | 42,695 | 48,740 | | |
| #7 | 3-1/2 | 15,005 | 17,335 | 19,660 | 36,000 | 54,000 |
| | 7-7/8 | 55,575 | 70,338 | 85,100 | | |
| #8 | 4 | 17,735 | 20,390 | 23,045 | 47,400 | 71,100 |
| | 9 | 62,250 | 73,850 | 85,450 | | |
| #10 | 5 | 34,695 | 36,935 | 39,170 | 79,200 | 114,300 |
| | 11-1/4 | 77,815 | 90,655 | 103,495 | | |
| #11 | 13 | 101,085 | 117,764 | 134,443 | 93,600 | 140,400 |

1. Allowable working loads for the single installations under static loading should not exceed 25% capacity of the ultimate load (to get the allowable load of the anchor rod, divide the ultimate load by 4).
2. Performance values are based on the use of ASTM A615 Grade 60 reinforcing bar. The use of lower strength rebar will result in lower ultimate tension loads
3. SHEAR DATA: Provided the distance from the rebar to the edge of the concrete member exceeds 1.25 times the embedment depth of the rebar, calculate the ultimate shear load for the rebar anchorage as 60% of the ultimate tensile strength of the rebar.

## ALLOWABLE STRESS DESIGN

**C6+ For the Most Demanding Jobs**

### Adhesive Edge/Spacing Distance Load Factor Summary for Installation of Threaded Rod and Reinforcing Bar [1,2]

| LOAD FACTOR | DISTANCE FROM EDGE OF CONCRETE |
|---|---|
| ***Critical Edge Distance—Tension*** | |
| 100% Tension Load → | 1.25 x Anchor Embedment (or greater) |
| ***Minimum Edge Distance—Tension*** | |
| 70% Tension Load → | 0.50 x Anchor Embedment |
| ***Critical Edge Distance—Shear*** | |
| 100% Shear Load → | 1.25 x Anchor Embedment (or greater) |
| ***Minimum Edge Distance—Shear*** | |
| 30% Shear Load → | 0.30 x Anchor Embedment |

| LOAD FACTOR | DISTANCE FROM ANOTHER ANCHOR |
|---|---|
| ***Critical Spacing—Tension*** | |
| 100% Tension Load → | 1.50 x Anchor Embedment (or greater) |
| ***Minimum Spacing—Tension*** | |
| 75% Tension Load → | 0.75 x Anchor Embedment |
| ***Critical Spacing—Shear*** | |
| 100% Shear Load → | 1.50 x Anchor Embedment (or greater) |
| ***Minimum Spacing—Shear*** | |
| 30% Shear Load → | 0.50 x Anchor Embedment |

1 Use linear interpolation for load factors at edge distances or spacing distances between critical and minimum.
2 Anchors are affected by multiple combination of spacing and/or edge distance loading and direction of the loading. Use the product of tension and shear loading factors in design.



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## STRENGTH DESIGN

**C6+**
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### Tension (lbf) and Shear (lbf) in Uncracked Concrete with ASTM A193 B7 Threaded Rod[1,2,3,4]

| ANCHOR DIAMETER (in.) | EMBEDMENT DEPTH (in.) | TENSION (lbf) 2500 psi | 3000 psi | 4000 psi | 5000 psi | 6000 psi | 7000-8000 psi | SHEAR (lbf) 2500-8000 psi |
|---|---|---|---|---|---|---|---|---|
| 3/8 | 3 3/8 | 4,835 | 5,295 | 6,115 | 6,380 | 6,380 | 6,380 | 3,775 |
| | 4 1/2 | 7,265 | 7,265 | 7,265 | 7,265 | 7,265 | 7,265 | 3,775 |
| | 7 1/2 | 7,265 | 7,265 | 7,265 | 7,265 | 7,265 | 7,265 | 3,775 |
| 1/2 | 4 1/2 | 7,445 | 8,155 | 9,415 | 10,530 | 10,980 | 10,980 | 6,915 |
| | 6 | 11,460 | 12,555 | 13,305 | 13,305 | 13,305 | 13,305 | 6,915 |
| | 10 | 13,305 | 13,305 | 13,305 | 13,305 | 13,305 | 13,305 | 6,915 |
| 5/8 | 5 5/8 | 10,405 | 11,395 | 13,160 | 14,715 | 16,120 | 16,615 | 11,015 |
| | 7 1/2 | 16,020 | 17,550 | 20,265 | 21,185 | 21,185 | 21,185 | 11,015 |
| | 12 1/2 | 21,185 | 21,185 | 21,185 | 21,185 | 21,185 | 21,185 | 11,015 |
| 3/4 | 6 3/4 | 13,675 | 14,980 | 17,300 | 19,345 | 19,590 | 19,590 | 16,305 |
| | 9 | 21,060 | 23,070 | 26,125 | 26,125 | 26,125 | 26,125 | 16,305 |
| | 15 | 31,355 | 31,355 | 31,355 | 31,355 | 31,355 | 31,355 | 16,305 |
| 7/8 | 7 7/8 | 17,235 | 18,880 | 21,800 | 24,375 | 25,715 | 25,715 | 22,505 |
| | 10 1/2 | 26,535 | 29,070 | 33,565 | 34,285 | 34,285 | 34,285 | 22,505 |
| | 17 1/2 | 43,280 | 43,280 | 43,280 | 43,280 | 43,280 | 43,280 | 22,505 |
| 1 | 9 | 21,060 | 23,070 | 26,635 | 29,780 | 32,420 | 32,420 | 29,525 |
| | 12 | 32,420 | 35,515 | 41,010 | 43,230 | 43,230 | 43,230 | 29,525 |
| | 20 | 56,780 | 56,780 | 56,780 | 56,780 | 56,780 | 56,780 | 29,525 |
| 1 1/4 | 11 1/4 | 29,430 | 32,240 | 37,225 | 41,620 | 45,595 | 46,895 | 47,240 |
| | 15 | 45,310 | 49,635 | 57,315 | 62,525 | 62,525 | 62,525 | 47,240 |
| | 25 | 90,855 | 90,855 | 90,855 | 90,855 | 90,855 | 90,855 | 47,240 |

1. Tabulated values are for estimation purposes only and should not be used for design (please use our free TruSpec anchorage design software at www.ITW-redhead.com)
2. Tabulated values represent strength design per ACI 318 for a single anchor in adequate concrete thickness, not near an edge nor adjacent anchorage, and not for sustained loading.
3. Bond strengths are for dry, uncracked concrete with periodic inspection
4. Bond strengths are for Temperature Range A (maximum long term temperature of 110F, maximum short term temperature of 142F).

## STRENGTH DESIGN

**C6+**
**For the Most Demanding Jobs**

### Tension (lbf) and Shear (lbf) in 4,000 psi Uncracked Concrete by Threaded Rod Type[1,2,3,4]

| ANCHOR DIAMETER (in.) | EMBEDMENT DEPTH (in.) | ASTM A193 B7 THREAD ROD | | CARBON STEEL A36 | | STAINLESS STEEL F593 | |
|---|---|---|---|---|---|---|---|
| | | TENSION (lbf) | SHEAR (lbf) | TENSION (lbf) | SHEAR (lbf) | TENSION (lbf) | SHEAR (lbf) |
| 3/8 | 3 3/8 | 6,115 | 3,775 | 3,375 | 1,755 | 4,785 | 2,280 |
| | 4 1/2 | 7,265 | 3,775 | 3,375 | 1,755 | 4,785 | 2,280 |
| | 7 1/2 | 7,265 | 3,775 | 3,375 | 1,755 | 4,785 | 2,280 |
| 1/2 | 4 1/2 | 9,415 | 6,915 | 6,170 | 3,210 | 8,760 | 4,040 |
| | 6 | 13,305 | 6,915 | 6,170 | 3,210 | 8,760 | 4,040 |
| | 10 | 13,305 | 6,915 | 6,170 | 3,210 | 8,760 | 4,040 |
| 5/8 | 5 5/8 | 13,160 | 11,015 | 9,830 | 5,115 | 13,160 | 6,440 |
| | 7 1/2 | 20,265 | 11,015 | 9,830 | 5,115 | 13,955 | 6,440 |
| | 12 1/2 | 21,185 | 11,015 | 9,830 | 5,115 | 13,955 | 6,440 |
| 3/4 | 6 3/4 | 17,300 | 16,305 | 14,550 | 7,565 | 16,500 | 7,610 |
| | 9 | 26,125 | 16,305 | 14,550 | 7,565 | 16,500 | 7,610 |
| | 15 | 31,355 | 16,305 | 14,550 | 7,565 | 16,500 | 7,610 |
| 7/8 | 7 7/8 | 21,800 | 22,505 | 20,085 | 10,445 | 21,800 | 10,530 |
| | 10 1/2 | 33,565 | 22,505 | 20,085 | 10,445 | 22,820 | 10,530 |
| | 17 1/2 | 43,280 | 22,505 | 20,085 | 10,445 | 22,820 | 10,530 |
| 1 | 9 | 26,635 | 29,525 | 26,345 | 13,700 | 26,635 | 13,815 |
| | 12 | 41,010 | 29,525 | 26,345 | 13,700 | 29,935 | 13,815 |
| | 20 | 56,780 | 29,525 | 26,345 | 13,700 | 29,935 | 13,815 |
| 1 1/4 | 11 1/4 | 37,225 | 47,240 | 37,225 | 21,920 | 37,225 | 22,090 |
| | 15 | 57,315 | 47,240 | 42,155 | 21,920 | 47,865 | 22,090 |
| | 25 | 90,855 | 47,240 | 42,155 | 21,920 | 47,865 | 22,090 |

1. Tabulated values are for estimation purposes only and should not be used for design (please use our free TruSpec anchorage design software at www.ITW-redhead.com)
2. Tabulated values represent strength design per ACI 318 for a single anchor in adequate concrete thickness, not near an edge nor adjacent anchorage, and not for sustained loading.
3. Bond strengths are for dry, uncracked concrete with periodic inspection
4. Bond strengths are for Temperature Range A (maximum long term temperature of 110F, maximum short term temperature of 142F).

## STRENGTH DESIGN

**C6+**
**For the Most Demanding Jobs**

### Tension (lbf) and Shear (lbf) in Cracked Concrete with ASTM A193 B7 Threaded Rod[1,2,3,4]

| ANCHOR DIAMETER (in.) | EMBEDMENT DEPTH (in.) | TENSION (lbf) 2500 psi | 3000 psi | 4000 psi | 5000 psi | 6000 psi | 7000-8000 psi | SHEAR (lbf) 2500-8000 psi |
|---|---|---|---|---|---|---|---|---|
| 3/8 | 3 3/8 | 2,905 | 2,905 | 2,905 | 2,905 | 2,905 | 2,905 | 3,775 |
| | 4 1/2 | 3,875 | 3,875 | 3,875 | 3,875 | 3,875 | 3,875 | 3,775 |
| | 7 1/2 | 6,460 | 6,460 | 6,460 | 6,460 | 6,460 | 6,460 | 3,775 |
| 1/2 | 4 1/2 | 5,165 | 5,165 | 5,165 | 5,165 | 5,165 | 5,165 | 6,915 |
| | 6 | 6,890 | 6,890 | 6,890 | 6,890 | 6,890 | 6,890 | 6,915 |
| | 10 | 11,485 | 11,485 | 11,485 | 11,485 | 11,485 | 11,485 | 6,915 |
| 5/8 | 5 5/8 | 7,370 | 8,070 | 8,075 | 8,075 | 8,075 | 8,075 | 11,015 |
| | 7 1/2 | 10,765 | 10,765 | 10,765 | 10,765 | 10,765 | 10,765 | 11,015 |
| | 12 1/2 | 17,945 | 17,945 | 17,945 | 17,945 | 17,945 | 17,945 | 11,015 |
| 3/4 | 6 3/4 | 9,685 | 10,610 | 10,975 | 10,975 | 10,975 | 10,975 | 15,365 |
| | 9 | 14,635 | 14,635 | 14,635 | 14,635 | 14,635 | 14,635 | 16,305 |
| | 15 | 24,395 | 24,395 | 24,395 | 24,395 | 24,395 | 24,395 | 16,305 |
| 7/8 | 7 7/8 | 12,210 | 13,375 | 14,940 | 14,940 | 14,940 | 14,940 | 20,915 |
| | 10 1/2 | 18,795 | 19,920 | 19,920 | 19,920 | 19,920 | 19,920 | 22,505 |
| | 17 1/2 | 33,200 | 33,200 | 33,200 | 33,200 | 33,200 | 33,200 | 22,505 |
| 1 | 9 | 14,915 | 16,340 | 18,865 | 19,515 | 19,515 | 19,515 | 27,320 |
| | 12 | 22,965 | 25,155 | 26,020 | 26,020 | 26,020 | 26,020 | 29,525 |
| | 20 | 43,365 | 43,365 | 43,365 | 43,365 | 43,365 | 43,365 | 29,525 |
| 1 1/4 | 11 1/4 | 20,845 | 22,835 | 26,370 | 29,480 | 32,295 | 33,285 | 46,600 |
| | 15 | 32,095 | 35,160 | 40,600 | 44,380 | 44,380 | 44,380 | 47,240 |
| | 25 | 69,060 | 73,970 | 73,970 | 73,970 | 73,970 | 73,970 | 47,240 |

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2. Tabulated values represent strength design per ACI 318 for a single anchor in adequate concrete thickness, not near an edge nor adjacent anchorage, and not for sustained loading.
3. Bond strengths are for dry, cracked concrete with periodic inspection
4. Bond strengths are for Temperature Range A (maximum long term temperature of 110F, maximum short term temperature of 142F).

## STRENGTH DESIGN

**C6+**
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### Tension (lbf) and Shear (lbf) in 4000 psi Cracked Concrete by Threaded Rod Type[1,2,3,4]

| ANCHOR DIAMETER (in.) | EMBEDMENT DEPTH (in.) | ASTM A193 B7 THREAD ROD | | CARBON STEEL A36 | | STAINLESS STEEL F593 | |
|---|---|---|---|---|---|---|---|
| | | TENSION (lbf) | SHEAR (lbf) | TENSION (lbf) | SHEAR (lbf) | TENSION (lbf) | SHEAR (lbf) |
| 3/8 | 3 3/8 | 2,905 | 3,775 | 3,375 | 1,755 | 4,785 | 2,280 |
| | 4 1/2 | 3,875 | 3,775 | 3,375 | 1,755 | 4,785 | 2,280 |
| | 7 1/2 | 6,460 | 3,775 | 3,375 | 1,755 | 4,785 | 2,280 |
| 1/2 | 4 1/2 | 5,165 | 6,915 | 6,170 | 3,210 | 8,760 | 4,040 |
| | 6 | 6,890 | 6,915 | 6,170 | 3,210 | 8,760 | 4,040 |
| | 10 | 11,485 | 6,915 | 6,170 | 3,210 | 8,760 | 4,040 |
| 5/8 | 5 5/8 | 8,075 | 11,015 | 9,830 | 5,115 | 13,160 | 6,440 |
| | 7 1/2 | 10,765 | 11,015 | 9,830 | 5,115 | 13,955 | 6,440 |
| | 12 1/2 | 17,945 | 11,015 | 9,830 | 5,115 | 13,955 | 6,440 |
| 3/4 | 6 3/4 | 10,975 | 15,365 | 14,550 | 7,565 | 16,500 | 7,610 |
| | 9 | 14,635 | 16,305 | 14,550 | 7,565 | 16,500 | 7,610 |
| | 15 | 24,395 | 16,305 | 14,550 | 7,565 | 16,500 | 7,610 |
| 7/8 | 7 7/8 | 14,940 | 20,915 | 20,085 | 10,445 | 21,800 | 10,530 |
| | 10 1/2 | 19,920 | 22,505 | 20,085 | 10,445 | 22,820 | 10,530 |
| | 17 1/2 | 33,200 | 22,505 | 20,085 | 10,445 | 22,820 | 10,530 |
| 1 | 9 | 19,515 | 27,320 | 26,345 | 13,700 | 26,635 | 13,815 |
| | 12 | 26,020 | 29,525 | 26,345 | 13,700 | 29,935 | 13,815 |
| | 20 | 43,365 | 29,525 | 26,345 | 13,700 | 29,935 | 13,815 |
| 1 1/4 | 11 1/4 | 33,285 | 46,600 | 37,225 | 21,920 | 37,225 | 22,090 |
| | 15 | 44,380 | 47,240 | 42,155 | 21,920 | 47,865 | 22,090 |
| | 25 | 73,970 | 47,240 | 42,155 | 21,920 | 47,865 | 22,090 |

1. Tabulated values are for estimation purposes only and should not be used for design (please use our free TruSpec anchorage design software at www.ITW-redhead.com)
2. Tabulated values represent strength design per ACI 318 for a single anchor in adequate concrete thickness, not near an edge nor adjacent anchorage, and not for sustained loading.
3. Bond strengths are for dry, cracked concrete with periodic inspection
4. Bond strengths are for Temperature Range A (maximum long term temperature of 110F, maximum short term temperature of 142F).



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## STRENGTH DESIGN

**C6+**
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### *Tension (lbf) and Shear (lbf) in Uncracked Concrete with ASTM A615 Grade 60 Reinforcing Bar[1,2,3,4]*

| ANCHOR DIAMETER # Rebar | EMBEDMENT DEPTH (in.) | TENSION (lbf) 2500 psi | 3000 psi | 4000 psi | 5000 psi | 6000 psi | 7000-8000 psi | SHEAR (lbf) 2500-8000 psi |
|---|---|---|---|---|---|---|---|---|
| #3 | 3 3/8 | 4,835 | 5,295 | 6,110 | 6,110 | 6,110 | 6,110 | 3,560 |
| | 4 1/2 | 6,435 | 6,435 | 6,435 | 6,435 | 6,435 | 6,435 | 3,560 |
| | 7 1/2 | 4,835 | 6,435 | 6,435 | 6,435 | 6,435 | 6,435 | 3,560 |
| #4 | 4 1/2 | 7,445 | 8,155 | 9,415 | 10,450 | 10,450 | 10,450 | 6,480 |
| | 6 | 11,460 | 11,700 | 11,700 | 11,700 | 11,700 | 11,700 | 6,480 |
| | 10 | 11,700 | 11,700 | 11,700 | 11,700 | 11,700 | 11,700 | 6,480 |
| #5 | 5 5/8 | 10,405 | 11,395 | 13,160 | 14,715 | 15,650 | 15,650 | 10,040 |
| | 7 1/2 | 16,020 | 17,550 | 18,135 | 18,135 | 18,135 | 18,135 | 10,040 |
| | 12 1/2 | 18,135 | 18,135 | 18,135 | 18,135 | 18,135 | 18,135 | 10,040 |
| #6 | 6 3/4 | 13,675 | 14,980 | 17,300 | 18,235 | 18,235 | 18,235 | 14,255 |
| | 9 | 21,060 | 23,070 | 24,315 | 24,315 | 24,315 | 24,315 | 14,255 |
| | 15 | 25,740 | 25,740 | 25,740 | 25,740 | 25,740 | 25,740 | 14,255 |
| #7 | 7 7/8 | 17,235 | 18,880 | 21,800 | 23,690 | 23,690 | 23,690 | 19,440 |
| | 10 1/2 | 26,535 | 29,070 | 31,590 | 31,590 | 31,590 | 31,590 | 19,440 |
| | 17 1/2 | 35,100 | 35,100 | 35,100 | 35,100 | 35,100 | 35,100 | 19,440 |
| #8 | 9 | 21,060 | 23,070 | 26,635 | 29,465 | 29,465 | 29,465 | 25,595 |
| | 12 | 32,420 | 35,515 | 39,290 | 39,290 | 39,290 | 39,290 | 25,595 |
| | 20 | 46,215 | 46,215 | 46,215 | 46,215 | 46,215 | 46,215 | 25,595 |
| #9 | 10 1/8 | 25,130 | 27,525 | 31,785 | 35,525 | 35,525 | 35,525 | 32,400 |
| | 13 1/2 | 38,690 | 42,380 | 47,365 | 47,365 | 47,365 | 47,365 | 32,400 |
| | 22 1/2 | 58,500 | 58,500 | 58,500 | 58,500 | 58,500 | 58,500 | 32,400 |
| #10 | 11 1/4 | 29,430 | 32,240 | 37,225 | 41,620 | 42,210 | 42,210 | 41,145 |
| | 15 | 45,310 | 49,635 | 56,285 | 56,285 | 56,285 | 56,285 | 41,145 |
| | 25 | 74,295 | 74,295 | 74,295 | 74,295 | 74,295 | 74,295 | 41,145 |

1. Tabulated values are for estimation purposes only and should not be used for design (please use our free TruSpec anchorage design software at www.ITW-redhead.com)
2. Tabulated values represent strength design per ACI 318 for a single anchor in adequate concrete thickness, not near an edge nor adjacent anchorage, and not for sustained loading.
3. Bond strengths are for dry, uncracked concrete with periodic inspection
4. Bond strengths are for Temperature Range A (maximum long term temperature of 110F, maximum short term temperature of 142F).

## STRENGTH DESIGN

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### *Tension (lbf) and Shear (lbf) in Cracked Concrete with ASTM A615 Grade 60 Reinforcing Bar [1,2,3,4]*

| ANCHOR DIAMETER # Rebar | EMBEDMENT DEPTH (in.) | TENSION (lbf) 2500 psi | 3000 psi | 4000 psi | 5000 psi | 6000 psi | 7000-8000 psi | SHEAR (lbf) 2500-8000 psi |
|---|---|---|---|---|---|---|---|---|
| #3 | 3 3/8 | 2,825 | 2,905 | 2,905 | 2,905 | 2,905 | 3,560 | 3,560 |
| | 4 1/2 | 3,875 | 3,875 | 3,875 | 3,875 | 3,875 | 3,560 | 3,560 |
| | 7 1/2 | 6,435 | 6,435 | 6,435 | 6,435 | 6,435 | 3,560 | 3,560 |
| #4 | 4 1/2 | 5,165 | 5,165 | 5,165 | 5,165 | 5,165 | 6,480 | 6,480 |
| | 6 | 6,890 | 6,890 | 6,890 | 6,890 | 6,890 | 6,480 | 6,480 |
| | 10 | 11,485 | 11,485 | 11,485 | 11,485 | 11,485 | 6,480 | 6,480 |
| #5 | 5 5/8 | 7,370 | 7,965 | 7,965 | 7,965 | 7,965 | 10,040 | 10,040 |
| | 7 1/2 | 10,620 | 10,620 | 10,620 | 10,620 | 10,620 | 10,040 | 10,040 |
| | 12 1/2 | 17,705 | 17,705 | 17,705 | 17,705 | 17,705 | 10,040 | 10,040 |
| #6 | 6 3/4 | 9,685 | 10,405 | 10,405 | 10,405 | 10,405 | 14,255 | 14,255 |
| | 9 | 13,875 | 13,875 | 13,875 | 13,875 | 13,875 | 14,255 | 14,255 |
| | 15 | 23,130 | 23,130 | 23,130 | 23,130 | 23,130 | 14,255 | 14,255 |
| #7 | 7 7/8 | 12,210 | 13,375 | 13,570 | 13,570 | 13,570 | 19,000 | 19,440 |
| | 10 1/2 | 18,095 | 18,095 | 18,095 | 18,095 | 18,095 | 19,440 | 19,440 |
| | 17 1/2 | 30,160 | 30,160 | 30,160 | 30,160 | 30,160 | 19,440 | 19,440 |
| #8 | 9 | 14,915 | 16,340 | 16,950 | 16,950 | 16,950 | 23,730 | 25,595 |
| | 12 | 22,600 | 22,600 | 22,600 | 22,600 | 22,600 | 25,595 | 25,595 |
| | 20 | 37,665 | 37,665 | 37,665 | 37,665 | 37,665 | 25,595 | 25,595 |
| #9 | 10 1/8 | 17,800 | 19,495 | 20,465 | 20,465 | 20,465 | 28,655 | 32,400 |
| | 13 1/2 | 27,290 | 27,290 | 27,290 | 27,290 | 27,290 | 32,400 | 32,400 |
| | 22 1/2 | 45,485 | 45,485 | 45,485 | 45,485 | 45,485 | 32,400 | 32,400 |
| #10 | 11 1/4 | 20,845 | 22,835 | 26,370 | 26,660 | 26,660 | 37,325 | 41,145 |
| | 15 | 32,095 | 35,160 | 35,545 | 35,545 | 35,545 | 41,145 | 41,145 |
| | 25 | 59,245 | 59,245 | 59,245 | 59,245 | 59,245 | 41,145 | 41,145 |

1. Tabulated values are for estimation purposes only and should not be used for design (please use our free TruSpec anchorage design software at www.ITW-redhead.com)
2. Tabulated values represent strength design per ACI 318 for a single anchor in adequate concrete thickness, not near an edge nor adjacent anchorage, and not for sustained loading.
3. Bond strengths are for dry, cracked concrete with periodic inspection
4. Bond strengths are for Temperature Range A (maximum long term temperature of 110F, maximum short term temperature of 142F).

## C6+ For the Most Demanding Jobs

## Grout-filled Concrete Block: Allowable Tension and Shear Loads based on Steel Design Information for U.S. Customary Unit Threaded Rod [1, 2, 3]

| Anchor Diameter (in.) | Tension (lb) | | | Shear (lb) | | |
|---|---|---|---|---|---|---|
| | ASTM A307 $F_u$ = 60 ksi | ASTM A193 Grade B7 $F_u$ = 125 ksi | ASTM F593 SS 304 $F_u$ = 100 ksi | ASTM A307 $F_u$ = 60 ksi | ASTM A193 Grade B7 $F_u$ = 125 ksi | ASTM F593 SS 304 $F_u$ = 100 ksi |
| 3/8 | 2,185 | 4,555 | 3,645 | 1,125 | 2,345 | 1,875 |
| 1/2 | 3,885 | 8,100 | 6,480 | 2,000 | 4,170 | 3,335 |
| 5/8 | 6,075 | 12,655 | 10,125 | 3,130 | 6,520 | 5,215 |
| 3/4 | 8,750 | 18,225 | 12,390 | 4,505 | 9,390 | 6,385 |

For SI: 1 inch = 25.4mm, 1 lbf = 4.45N, 1ft-lbf = 1.356 N-M, 1 psi = 0.006895 MPa

1. Allowable load used in the design must be the lesser of bond values and tabulated steel element values.
2. Allowable tension and shear loads for threaded rods to resist short term loads, such as wind or seismic, must be calculated in accordance with Section 4.1 as applicable.
3. Allowable steel loads are based on allowable tension and shear stresses equal to 0.33X $F_u$ and 0.17x$F_u$, respectively.

MASONRY DESIGN

## C6+ For the Most Demanding Jobs

## Grout-filled Concrete Block: Allowable Tension Loads for Threaded Rod [1, 2, 3, 4, 7, 9, 10, 11, 12]

| Threaded Rod Size (in.) | Minimum Embedment (inches) | Load at $s_{cr}$ and $c_{cr}$ (lb) | Spacing[5] | | | Edge Distance[6] | | |
|---|---|---|---|---|---|---|---|---|
| | | | Critical $s_{cr}$ (inches) | Minimum $s_{min}$ (inches) | Load reduction factor for $s_{min}$ [8] | Critical $c_{cr}$ (inches) | Minimum $c_{min}$ (inches) | Load reduction factor for $c_{min}$ [8] |
| 3/8 | 3 ⅜ | 945 | 13.5 | 4 | 1.00 | 12 | 4 | 0.87 |
| 1/2 | 4 ½ | 1,395 | 18 | 4 | 0.50 | 20 | 4 | 0.68 |
| 5/8 | 5 ⅝ | 1,825 | 22.5 | 4 | 0.50 | 20 | 4 | 0.68 |
| 3/4 | 6 ¾ | 2,085 | 27 | 4 | 0.50 | 20 | 4 | 0.68 |

For SI: 1 inch = 25.4mm, 1 lbf = 0.0044kN, 1 ksi = 6.894 MPa
See footnotes below

MASONRY DESIGN

## C6+ For the Most Demanding Jobs

## Grout-filled Concrete Block: Allowable Shear Loads for Threaded Rod [1, 2, 3, 4, 7, 9, 10, 11, 12]

| Threaded Rod Size (in.) | Minimum Embedment (inches) | Load at *scr* and $c_{cr}$ ⊥ to edge (lb) | Spacing[5] | | | Edge Distance[6] | | |
|---|---|---|---|---|---|---|---|---|
| | | | Critical $s_{cr}$ (inches) | Minimum $s_{min}$ (inches) | Load reduction factor for $s_{min}$ [8] | Critical $c_{cr}$ (inches) | Minimum $c_{min}$ (inches) | Load reduction factor for $c_{min}$ [8] |
| 3/8 | 3 ⅜ | 825 | 13.5 | 4 | 0.50 | 12 | 4 | 0.87 |
| 1/2 | 4 ½ | 1,560 | 18 | 4 | 0.50 | 20 | 4 | 0.56 |
| 5/8 | 5 ⅝ | 2,680 | 22.5 | 4 | 0.50 | 20 | 4 | 0.30 |
| 3/4 | 6 ¾ | 3,180 | 27 | 4 | 0.50 | 20 | 4 | 0.27 |

For SI: 1 inch = 25.4mm, 1 lbf = 0.0044kN, 1 ksi = 6.894 MPa

1. All values are for anchors installed in fully grouted concrete masonry with minimum masonry strength of 1500 psi (10.3 MPa). Concrete masonry units must be light-, medium, or normal-weight conforming to ASTM C 90. Allowable loads have been calculated using a safety factor of 5.0.
3. Anchors may be installed in any location in the face of the masonry wall (cell, web, bed joint).
4. A maximum of two anchors may be installed in a single masonry cell in accordance with the spacing and edge or end distance requirements. Embedment is measured from the outside surface of the concrete masonry unit to the embedded end of the anchor.
5. The critical spacing distance, scr, is the anchor spacing where full load values in the table may be used. The minimum spacing distance, smin, is the minimum anchor spacing for which values are available and installation is permitted. Spacing distance is measured from the centerline to centerline between two anchors.
6. The critical edge or end distance, ccr, is the distance where full load values in the table may be used. The minimum edge or end distance, cmin, is the minimum distance for which values are available and installation is permitted. Edge or end distance is measured from anchor centerline to the closest unrestrained edge.
7. The tabulated values are applicable for anchors in the ends of grout-filled concrete masonry units where minimum edge distances are maintained.
8. Load values for anchors installed less than scr and ccr must be multiplied by the appropriate load reduction factor based on actual spacing (s) or edge distance (c). Load factors are multiplicative; both spacing and edge reduction factors must be considered.
9. Linear interpolation of load values between minimum spacing (smin) and critical spacing (scr) and between minimum edge or end distance (cmin) and critical edge or end distance (ccr) is permitted.
10. Concrete masonry width (wall thickness) must be equal to or greater than 1.5 times the anchor embedment depth (e.g. 3/8-inch- and 1/2-inch-diameter anchors are permitted in minimum nominally 6-inch-thick concrete masonry). The 5/8- and 3/4-inch-diameter anchors must be installed in minimum nominally 8-inch-thick concrete masonry.
11. Allowable loads must be the lesser of the adjusted masonry or bond values tabulated above and the steel strength values.
12. Tabulated allowable bond loads must be adjusted for increased in-service base material temperatures.



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## Grout-filled Concrete Block: Allowable Tension and Shear Loads Based on Steel Strength for Rebar [1, 2, 3]

| Rebar Size | Tension (lb) | Shear (lb) |
|---|---|---|
| | ASTM A615, Grade 60 | ASTM A615, Grade 60 |
| #3 | 3,270 | 1,685 |
| #4 | 5,940 | 3,060 |
| #5 | 9,205 | 4,745 |
| #6 | 13,070 | 6,730 |

For SI: 1 inch = 25.4mm, 1 lbf = 4.45N, 1ft-lbf = 1.356 N-M, 1 psi = 0.006895 MPa

1. Allowable load used in the design must be the lesser of bond values and tabulated steel element values.
2. Allowable tension and shear loads for threaded rods to resist short term loads, such as wind or seismic, must be calculated in accordance with Section 4.1 as applicable.
3. Allowable steel loads are based on allowable tension and shear stresses equal to 0.33X $F_u$ and 0.17x$F_u$, respectively.

MASONRY DESIGN

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## Grout-filled Concrete Block: Allowable Tension Loads for Rebar [1, 2, 3, 4, 7, 9, 10, 11, 12]

| Rebar Size | Minimum Embedment (inches) | Load at scr and $c_{cr}$ (lb) | Spacing[5] | | | Edge Distance[6] | | |
|---|---|---|---|---|---|---|---|---|
| | | | Critical $s_{cr}$ (inches) | Minimum $s_{min}$ (inches) | Load reduction factor for $s_{min}$ [8] | Critical $c_{cr}$ (inches) | Minimum $c_{min}$ (inches) | Load reduction factor for $c_{min}$ [8] |
| #3 | 3 ⅜ | 785 | 13.5 | 4 | 1.00 | 12 | 4 | 0.87 |
| #4 | 4 ½ | 1,355 | 18 | 4 | 0.50 | 20 | 4 | 0.68 |
| #5 | 5 ⅝ | 2,060 | 22.5 | 4 | 0.50 | 20 | 4 | 0.68 |
| #6 | 6 ¾ | 2,415 | 27 | 4 | 0.50 | 20 | 4 | 0.68 |

For SI: 1 inch = 25.4mm, 1 lbf = 0.0044kN, 1 ksi = 6.894 MPa
See footnotes below

MASONRY DESIGN

**C6+**
***For the Most Demanding Jobs***

## Grout-filled Concrete Block: Allowable Shear Loads for Threaded Rebar [1, 2, 3, 4, 7, 9, 10, 11, 12]

| Rebar Size | Minimum Embedment (inches) | Load at scr and $c_{cr}$ ⊥ to edge (lb) | Spacing[5] | | | Edge Distance[6] | | |
|---|---|---|---|---|---|---|---|---|
| | | | Critical $s_{cr}$ (inches) | Minimum $s_{min}$ (inches) | Load reduction factor for $s_{min}$ [8] | Critical $c_{cr}$ (inches) | Minimum $c_{min}$ (inches) | Load reduction factor for $c_{min}$ [8] |
| #3 | 3 ⅜ | 1,230 | 13.5 | 4 | 0.50 | 12 | 4 | |
| #4 | 4 ½ | 2,340 | 18 | 4 | 0.50 | 12 | 4 | |
| #5 | 5 ⅝ | 3,600 | 22.5 | 4 | 0.50 | 20 | 4 | |
| #6 | 6 ¾ | 3,685 | 27 | 4 | 0.50 | 20 | 4 | |

For SI: 1 inch = 25.4 mm; 1 lbf = 0.0044 kN, 1 ksi = 6.894 MPa.

1. All values are for anchors installed in fully grouted concrete masonry with minimum masonry strength of 1500 psi (10.3 MPa). Concrete masonry units must be light-, medium, or normal-weight conforming to ASTM C 90. Allowable loads have been calculated using a safety factor of 5.0.
3. Anchors may be installed in any location in the face of the masonry wall (cell, web, bed joint).
4. A maximum of two anchors may be installed in a single masonry cell in accordance with the spacing and edge or end distance requirements. Embedment is measured from the outside surface of the concrete masonry unit to the embedded end of the anchor.
5. The critical spacing distance, $s_{cr}$, is the anchor spacing where full load values in the table may be used. The minimum spacing distance, $s_{min}$, is the minimum anchor spacing for which values are available and installation is permitted. Spacing distance is measured from the centerline to centerline between two anchors.
6. The critical edge or end distance, $c_{cr}$, is the distance where full load values in the table may be used. The minimum edge or end distance, $c_{min}$, is the minimum distance for which values are available and installation is permitted. Edge or end distance is measured from anchor centerline to the closest unrestrained edge.
7. The tabulated values are applicable for anchors in the ends of grout-filled concrete masonry units where minimum edge distances are maintained.
8. Load values for anchors installed less than $s_{cr}$ and $c_{cr}$ must be multiplied by the appropriate load reduction factor based on actual spacing (s) or edge distance (c). Load factors are multiplicative; both spacing and edge reduction factors must be considered.
9. Linear interpolation of load values between minimum spacing ($s_{min}$) and critical spacing ($s_{cr}$) and between minimum edge or end distance ($c_{min}$) and critical edge or end distance ($c_{cr}$) is permitted.
10. Concrete masonry width (wall thickness) must be equal to or greater than 1.5 times the anchor embedment depth (e.g. No. 3 and No. 4 reinforcing bars are permitted in minimum nominally 6-inch-thick concrete masonry). No. 5 and No. 6 reinforcing bars must be installed in minimum nominally 8-inch-thick concrete masonry.
11. Allowable loads must be the lesser of the adjusted masonry or bond values tabulated above and the steel strength values.
12. Tabulated allowable bond loads must be adjusted for increased in-service base material temperatures.

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# ICC-ES Evaluation Report

# ESR-4046

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Issued 09/2017
This report is subject to renewal 09/2018.

**DIVISION: 03 00 00—CONCRETE**
**SECTION: 03 16 00—CONCRETE ANCHORS**
**DIVISION: 05 00 00—METALS**
**SECTION: 05 05 19—POST-INSTALLED CONCRETE ANCHORS**

**REPORT HOLDER:**

## ITW RED HEAD

**700 HIGH GROVE BOULEVARD**
**GLENDALE HEIGHTS, ILLINOIS 60139**

**EVALUATION SUBJECT:**

## ITW RED HEAD C6+ ADHESIVE ANCHORING SYSTEM FOR CRACKED AND UNCRACKED CONCRETE

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# ICC-ES Evaluation Report

**ESR-4046**

*Issued September 2017*
*This report is subject to renewal September 2018.*

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**DIVISION: 03 00 00—CONCRETE**
**Section: 03 16 00—Concrete Anchors**

**DIVISION: 05 00 00—METALS**
**Section: 05 05 19—Post-Installed Concrete Anchors**

**REPORT HOLDER:**

**ITW RED HEAD**
**700 HIGH GROVE BOULEVARD**
**GLENDALE HEIGHTS, ILLINOIS 60139**
**(800) 848-5611**
**www.itw-redhead.com**
**techsupport@itwccna.com**

**EVALUATION SUBJECT:**

**ITW RED HEAD C6+ ADHESIVE ANCHORING SYSTEM FOR CRACKED AND UNCRACKED CONCRETE**

## 1.0 EVALUATION SCOPE

**Compliance with the following codes:**

- 2015, 2012, 2009, 2006 and 2003 *International Building Code®* (IBC)
- 2015, 2012, 2009, 2006 and 2003 *International Residential Code®* (IRC)

**Property evaluated:**

Structural

## 2.0 USES

The Red Head C6+ Adhesive Anchoring System is a post-installed adhesive anchorage system used to resist static, wind or earthquake (for use in structures assigned to Seismic Design Categories A through F) tension and shear loads in cracked and uncracked normalweight concrete, having a specified compressive strength, $f'_c$, of 2500 psi to 8,500 psi (17.2 MPa to 58.6 MPa).

The anchoring system complies with requirements for anchors as described in Section 1901.3 of the 2015 IBC, Section 1909 of the 2012 IBC and is an alternative to cast-in-place anchors described in Section 1908 of the 2012 IBC, and Sections 1911 and 1912 of the 2009 and 2006 IBC, and Sections 1912 and 1913 of the 2003 IBC. The anchoring systems may also be used where an engineered design is submitted in accordance with Section R301.1.3 of the IRC.

## 3.0 DESCRIPTION

### 3.1 General:

The Red Head C6+ Adhesive Anchoring System consists of a two-component, high-strength, structural adhesive, and anchor elements (continuously threaded rods or deformed steel reinforcing bars) installed in normalweight concrete. The primary components of the Red Head C6+ Adhesive Anchoring Systems supplied by the report holder are shown in Figure 1 of this report.

The manufacturer's printed installation instructions (MPII) are included with the adhesive packaging and are replicated in Figure 3 of this report.

### 3.2 Materials:

**3.2.1 Red Head C6+ Adhesive:** The primary component of Red Head C6+ Adhesive Anchoring System is a two-part epoxy packaged in a dual-chamber cartridge at a volumetric ratio of 2:1. The cartridge is available in 30-ounce (side-by-side) or 15-ounce (side-by-side) sizes. The adhesive components are dispensed through a static mixing nozzle, supplied by ITW, which is attached to the cartridge. The original, unopened cartridge has a shelf life of 24 months, as indicated by the "best used by" date stamped onto the cartridge, when stored in a cool (50°F to 77°F), dry, ventilated area and in accordance with Figure 3.

**3.2.2 Hole Cleaning Equipment:** Hole cleaning equipment consists of wire brushes, as shown in Figures 1 and 3, and a compressed air nozzle with extension.

**3.2.3 Dispensing Tools:** Red Head C6+ Adhesive must be dispensed with manual or pneumatic or battery-operated dispensing tools provided by ITW Red Head, as shown in Figure 1.

**3.2.4 Anchor Elements:**

**3.2.4.1 Threaded Rods:** The continuously threaded rods must range from $^3/_8$ inch through $1^1/_4$ inches (9.5 mm through 31.75 mm) in diameter. Carbon steel threaded rods must comply with either ASTM A36 [minimum $f_{uta}$ = 58,000 psi (400 MPa)] or ASTM A193, Grade B7 [minimum $f_{uta}$ = 125,000 psi (860 MPa)]. Stainless steel threaded rods must comply with ASTM F593 (Alloy Type 300, CW1 and CW2) [minimum $f_{uta}$ = 95,000 psi (655 MPa) for CW1, and $f_{uta}$ =80,000 psi (552 MPa) for CW2]. Table 1 provides steel design information for the threaded rods. Carbon steel threaded rods must be furnished with a minimum 0.0002-inch-thick (5 μm) zinc electroplated coating complying with ASTM B633 SC1 or must be hot-dipped galvanized complying with ASTM A153, Class C or D. Threaded steel rods must be straight and free from indentations or other defects along their length.

**3.2.4.2 Steel Reinforcing Bars:** Steel reinforcing bars must be deformed reinforcing bars as described in Table 5 of this report. The embedded portions of reinforcing bars

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must be straight, and free of mill scale, rust, mud, oil, and other coatings that may impair the bond with the adhesive. Reinforcing bars must not be bent after installation, except as set forth in ACI 318-14 Section 26.6.3.1 (b) or ACI 318-11 Section 7.3.2, as applicable, with the additional condition that the bars must be bent cold, and heating of reinforcing bars to facilitate field bending is not permitted.

**3.2.4.3 Ductility:** In accordance with ACI 318-14 Section 2.3 or ACI 318-11 Appendix D Section D.1, as applicable, in order for a steel element to be considered ductile, the tested elongation must be at least 14 percent and reduction of area must be at least 30 percent. Steel elements with a tested elongation of less than 14 percent or a reduction of area of less than 30 percent, or both, are considered brittle. Where values are nonconforming or unstated, the steel must be considered brittle.

**3.3 Concrete:**

Normalweight concrete must comply with Sections 1903 and 1905 of the IBC. The specified compressive strength of the concrete must be from 2,500 psi to 8,500 psi (17.2 MPa to 58.6 MPa).

## 4.0 DESIGN AND INSTALLATION

### 4.1 Strength Design:

**4.1.1 General:** The design strength of anchors under the 2015 IBC, as well as the 2015 IRC must be determined in accordance with ACI 318-14 and this report. The design strength of anchors under the 2012, 2009, 2006 and 2003 IBC, as well as the 2012, 2009, 2006 and 2003 IRC, must be determined in accordance with ACI 318-11 and this report.

A design example in accordance with the 2012 IBC based on ACI 318-11 is provided in Figure 2 of this report.

Design parameters are based on ACI 318-14 for use with the 2015 IBC, and the ACI 318-11 for use with the 2012, 2009, 2006 and 2003 IBC unless noted otherwise in this report.

The strength design of anchors must comply with ACI 318-14 17.3.1 or ACI 318-11 D.4.1, as applicable, except as required in ACI 318-14 17.2.3 or ACI 318-11 D.3.3, as applicable. Design parameters are provided in Tables 1 through 6. Strength reduction factors, $\phi$, as given in ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable, must be used for load combinations calculated in accordance with Section 1605.2 of the IBC or ACI 318-14 5.3 or ACI 318-11 9.2, as applicable. Strength reduction factors, $\phi$, as described in ACI 318-11 D.4.4, must be used for load combinations calculated in accordance with ACI 318-11 Appendix C.

**4.1.2 Static Steel Strength in Tension:** The nominal static steel strength of a single anchor in tension, $N_{sa}$, in accordance with ACI 318-14 17.4.1.2 or ACI 318-11 D.5.1.2, as applicable, and the associated strength reduction factors, $\phi$, in accordance with ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable, are given in Tables 1 and 5 of this report for the anchor element types included in this report.

**4.1.3 Static Concrete Breakout Strength in Tension:** The nominal static concrete breakout strength of a single anchor or group of anchors in tension, $N_{cb}$ or $N_{cbg}$, must be calculated in accordance with ACI 318-14 17.4.2 or ACI 318-11 D.5.2, as applicable, with the following addition:

The basic concrete breakout strength of a single anchor in tension, $N_b$, must be calculated in accordance with ACI 318-14 17.4.2.2 or ACI 318-11 D.5.2.2, as applicable, using the values of $k_{c,cr}$, and $k_{c,uncr}$ as described in Tables 2 and 6 of this report. Where analysis indicates no cracking in accordance with ACI 318-14 17.4.2.6 or ACI 318-11 D.5.2.6, as applicable, $N_b$ must be calculated using $k_{c,\ uncr}$ and $\Psi_{c,N}$ = 1.0. For anchors in lightweight concrete see ACI 318-14 17.2.6 or ACI 318-11 D.3.6, as applicable. The value of $f'_c$ used for calculation must be limited to 8,000 psi (55 MPa) in accordance with ACI 318-14 17.2.7 or ACI 318-11 D.3.7, as applicable. Additional information for the determination of nominal bond strength in tension is given in Section 4.1.4 of this report.

**4.1.4 Static Bond Strength in Tension:** The nominal static bond strength of a single adhesive anchor or group of adhesive anchors in tension, $N_a$ or $N_{ag}$, must be calculated in accordance with ACI 318-14 17.4.5 or ACI 318-11 D.5.5, as applicable. Bond strength values are a function of whether the concrete is cracked or uncracked, the concrete temperature range, the installation conditions (dry or water-saturated concrete, water-filled holes, or submerged), and the level of inspection provided. The resulting characteristic bond strength must be multiplied by the associated strength reduction factor $\phi_{nn}$ as follows:

| CONCRETE TYPE | PERMISSIBLE INSTALLATION CONDITIONS | BOND STRENGTH | ASSOCIATED STRENGTH REDUCTION FACTOR |
|---|---|---|---|
| Uncracked | Dry | $\tau_{uncr}$ | $\phi_d$ |
| | Water-saturated | $\tau_{uncr}$ | $\phi_{ws}$ |
| | Water-filled holes | $\tau_{uncr}$ | $\phi_{wf}$ |
| | Submerged | $\tau_{uncr}$ | $\phi_{sub}$ |
| Cracked | Dry | $\tau_{cr}$ | $\phi_d$ |
| | Water-saturated | $\tau_{cr}$ | $\phi_{ws}$ |
| | Water-filled holes | $\tau_{cr}$ | $\phi_{wf}$ |
| | Submerged | $\tau_{cr}$ | $\phi_{sub}$ |

Strength reduction factors for determination of the bond strength are given in Tables 3, 4, 7 and 8 of this report.

**4.1.5 Static Steel Strength in Shear:** The nominal static strength of a single anchor in shear as governed by the steel, [illegible], in accordance with ACI 318-14 17.5.1.2 or ACI 318-11 D.6.1.2, as applicable, and strength reduction factors, $\phi$, in accordance with ACI 318-14 17.2.3 or ACI 318-11 D.4.3, as applicable are given in Tables 1 and 5 of this report for the anchor element types included in this report.

**4.1.6 Static Concrete Breakout Strength in Shear:** The nominal concrete breakout strength of a single anchor or group of anchors in shear, $V_{cb}$ or $V_{cbg}$, must be calculated in accordance with ACI 318-14 17.5.2 or ACI 318-11 D.6.2, as applicable, based on information given in Table 2 and Table 6 of this report. The basic concrete breakout strength of a single anchor in shear, $V_b$, must be calculated in accordance with ACI 318-14 17.5.2.2 or ACI 318-11 D.6.2.2, as applicable, using the values of $d$ given in this report in lieu of $d_a$ (2015, 2012 and 2009 IBC), $d_o$ (2006 IBC). In addition, $h_{ef}$ must be substituted for $\ell_e$. In no case shall $\ell_e$ exceed 8$d$. The value of $f'_c$ must be limited to a maximum value of 8,000 psi (55 MPa) in accordance with ACI 318-14 17.2.7 or ACI 318-11 D.3.7, as applicable.

**4.1.7 Static Concrete Pryout Strength in Shear:** The nominal static pryout strength of a single anchor or group of anchors in shear, $V_{cp}$ or $V_{cpg}$, shall be calculated in

accordance with ACI 318-14 17.5.3 or ACI 318-11 D.6.3, as applicable.

**4.1.8 Interaction of Tensile and Shear Forces:** For designs that include combined tension and shear, the interaction of tension and shear loads must be calculated in accordance with ACI 318-14 17.6 or ACI 318-11 D.7, as applicable.

**4.1.9 Minimum Member Thickness, $h_{min}$, Anchor Spacing, $s_{min}$, and Edge Distance, $c_{min}$:** In lieu of ACI 318-14 17.7.1 and 17.7.3 or ACI 318-11 D.8.1 and D.8.3, as applicable, values of $s_{min}$ and $c_{min}$, as given in Table 2 and Table 6 of this report, must be observed for anchor design and installation. The minimum member thicknesses $h_{min}$, as given in Table 2 and Table 6 of this report must be observed for anchor design and installation. For adhesive anchors that will remain untorqued, ACI 318-14 17.7.4 or ACI 318-11 D.8.4, as applicable, applies.

**4.1.10 Critical Edge Distance $c_{ac}$ and $\psi_{cp,Na}$:** The modification factor $\psi_{cp,Na}$, must be determined in accordance with ACI 318-14 17.4.5.5 or ACI 318-11 D.5.5.5, as applicable, except as noted below:

For all cases where $c_{Na}/c_{ac}<1.0$, $\psi_{cp,Na}$ determined from ACI 318-14 Eq. 17.4.5.5b or ACI 318-11 Eq. D-27, as applicable, need not be taken less than $c_{Na}/c_{ac}$. For all other cases, $\psi_{cp,Na}$ shall be taken as 1.0.

The critical edge distance, $c_{ac}$ must be calculated according to Eq. 17.4.5.5c for ACI 318-14 or Eq. D-27a for ACI 318-11, in lieu of ACI 318-14 17.7.6 or ACI 318-11 D.8.6, as applicable.

$$c_{ac} = h_{ef} \cdot \left(\frac{\tau_{k,uncr}}{1160}\right)^{0.4} \cdot \left(10.1 - 0.7\frac{h}{h_{ef}}\right)$$

(Eq. 17.4.5.5c for ACI 318-14 or Eq. D-27a for ACI 318-11)

where

$\left(\frac{h}{h_{ef}}\right)$ need not be taken as larger than 2.4; and

$\tau_{k,uncr}$ = the characteristic bond strength stated in the tables of this report whereby $\tau_{k,uncr}$ need not be taken as larger than:

$$\tau_{k,uncr} = \frac{\sqrt{\tau_{k,cr} \cdot \tau_{k,cr}}}{\phi \cdot \phi} \qquad \text{Eq. (4-1)}$$

**4.1.11 Design Strength in Seismic Design Categories C, D, E and F:** In structures assigned to Seismic Design Category C, D, E or F under the IBC or IRC, anchors must be designed in accordance with ACI 318-14 17.2.3 or ACI 318-11 D.3.3, as applicable, except as described below. Modifications to ACI 318-14 17.2.3 shall be applied under Section 1905.1.8 of the 2015 IBC. For the 2012 IBC, Section 1905.1.9 shall be omitted. The nominal steel shear strength, $V_{sa}$, must be adjusted by $\alpha_{V,seis}$ as given in Tables 1 and 5 for the anchor element types included in this report. The nominal bond strength $\tau_{k,cr}$ must be adjusted by $\alpha_{N,seis}$, as given in Tables 3, 4, 7 and 8 of this report.

As an exception to ACI 318-11 D.3.3.4.2: Anchors designed to resist wall out-of-plane forces with design strengths equal to or greater than the force determined in accordance with ASCE 7 Equation 12.11-1 or 12.14-10 shall be deemed to satisfy ACI 318-11 D.3.3.4.3(d).

Under ACI 318-11 D.3.3.4.3(d), in lieu of requiring the anchor design tensile strength to satisfy the tensile strength requirements of ACI 318-11 D.4.1.1, the anchor design tensile strength shall be calculated from ACI 318-11 D.3.3.4.4.

The following exceptions apply to ACI 318-11 D.3.3.5.2:

1. For the calculation of the in-plane shear strength of anchor bolts attaching wood sill plates of bearing or non-bearing walls of light-frame wood structures to foundations or foundation stem walls, the in-plane shear strength in accordance with ACI 318-11 D.6.2 and D.6.3 need not be computed and ACI 318-11 D.3.3.5.3 need not apply provided all the following are satisfied:

   1.1. The allowable in-plane shear strength of the anchor is determined in accordance with AF&PA NDS Table 11E for lateral design values parallel to grain.

   1.2. The maximum anchor nominal diameter is $^5/_8$ inch (16 mm).

   1.3. Anchor bolts are embedded into concrete a minimum of 7 inches (178 mm).

   1.4. Anchor bolts are located a minimum of $1^3/_4$ inches (45 mm) from the edge of the concrete parallel to the length of the wood sill plate.

   1.5. Anchor bolts are located a minimum of 15 anchor diameters from the edge of the concrete perpendicular to the length of the wood sill plate.

   1.6. The sill plate is 2-inch or 3-inch nominal thickness.

2. For the calculation of the in-plane shear strength of anchor bolts attaching cold-formed steel track of bearing or non-bearing walls of light-frame construction to foundations or foundation stem walls, the in-plane shear strength in accordance with ACI 318-11 D.6.2 and D.6.3 need not be computed and ACI 318-11 D.3.3.5.3 need not apply provided all the following are satisfied:

   2.1. The maximum anchor nominal diameter is $^5/_8$ inch (16 mm).

   2.2. Anchors are embedded into concrete a minimum of 7 inches (178 mm).

   2.3. Anchors are located a minimum of $1^3/_4$ inches

   (45 mm) from the edge of the concrete parallel to the length of the track.

   2.4. Anchors are located a minimum of 15 anchor diameters from the edge of the concrete perpendicular to the length of the track.

   2.5. The track is 33 to 68 mil designation thickness.

   Allowable in-plane shear strength of exempt anchors, parallel to the edge of concrete shall be permitted to be determined in accordance with AISI S100 Section E3.3.1.

3. In light-frame construction, bearing or nonbearing walls, shear strength of concrete anchors less than or equal to 1 inch [25 mm] in diameter attaching a sill plate or track to foundation or foundation stem wall need not satisfy ACI 318-11 D.3.3.5.3(a) through (c) when the design strength of the anchors is determined in accordance with ACI 318-11 D.6.2.1(c).

**4.2 Allowable Stress Design:**

**4.2.1 General:** For anchor systems designed using load combinations in accordance with IBC Section 1605.3 (Allowable Stress Design), allowable loads shall be established using Eq. (4-2) or Eq. (4-3):

$$V_{a,ASD} = \frac{\phi V_n}{\alpha} \qquad \text{Eq. (4-2)}$$

and

$$T_{a,ASD} = \frac{\phi T_n}{\alpha} \qquad \text{Eq. (4-3)}$$

where

$T_{allowable,ASD}$ = Allowable tension load (lbf or kN)

$V_{allowable,ASD}$ = Allowable shear load (lbf or kN)

$\phi N_n$ = Lowest design strength of an anchor or anchor group in tension as determined in accordance with ACI 318-14 Chapter 17 and 2015 IBC Section 1905.1.8, ACI 318-11 Appendix D, ACI 318-08 Appendix D and 2009 IBC Sections 1908.1.9 and 1908.1.10, ACI 318-05 Appendix D and 2006 IBC Section 1908.1.16, and Section 4.1 of this report, as applicable.

$\phi V_n$ = Lowest design strength of an anchor or anchor group in shear as determined in accordance with ACI 318-14 Chapter 17 and 2015 IBC Section 1905.1.8, ACI 318-11 Appendix D, ACI 318-08 Appendix D and 2009 IBC Sections 1908.1.9 and 1908.1.10, ACI 318-05 Appendix D and 2006 IBC Section 1908.1.16, and Section 4.1 of this report, as applicable.

[illegible] = Conversion factor calculated as a weighted average of the load factors for the controlling load combination. In addition, [illegible] must include all applicable factors to account for non-ductile failure modes and required over-strength.

Limits on edge distance, anchor spacing and member thickness described in this report must apply.

Example calculations for derivation of $T_{allowable,ASD}$ are provided in Figure 2 and Table 9.

**4.2.2 Interaction of tensile and shear forces**: In lieu of ACI 318-14 17.6.1, 17.6.2 and 17.6.3 or ACI 318-11 D.7.1, D.7.2 and D.7.3, as applicable, interaction must be calculated as follows:

For shear loads $V \leq 0.2V_{allowable,ASD}$, the full allowable load in tension shall be permitted.

For tension loads $T \leq 0.2T_{allowable,ASD}$, the full allowable load in shear shall be permitted.

For all other cases:

[illegible] Eq. (4-4)

**4.3 Installation:**

Installation parameters are illustrated in Figure 3 of this report. Installation must be in accordance with ACI 318-14 17.8.1 and 17.8.2 or ACI 318-11 D.9.1 and D.9.2, as applicable. Anchor locations must comply with this report and the plans and specifications approved by the code official. Installation of the Red Head C6+ Adhesive Anchoring System must conform to the manufacturer's printed installation instructions included in each unit package, as provided in Figure 3 of this report.

The adhesive anchoring system may be used for floor (vertically down), wall (horizontal) and overhead applications. Horizontal and overhead applications are to be used with the $^3/_8$-inch (9.5 mm) through $1^1/_4$-inch-diameter (31 mm) threaded rods and reinforcing bars. For the $^3/_8$-inch diameter (9.5 mm) and $^1/_2$-inch diameter (12 mm), the adhesive may be injected directly to the bottom/back of the hole using extension tubing or nozzle. The $^5/_8$-inch (16 mm) through $1^1/_4$-inch (31 mm) diameter threaded rod and reinforcing bars must be installed with a Red Head piston plug.

**4.4 Special Inspection:**

**4.4.1 General:** Installations may be made under continuous special inspection or periodic special inspection, as determined by the registered design professional. Tables 3, 4, 7 and Table 8 of this report provide strength reduction factors, $\phi$, corresponding to the type of inspection provided.

Continuous special inspection of adhesive anchor systems installed in horizontal or upwardly inclined orientations to resist sustained tension loads shall be performed in accordance with ACI 318-14 17.8.2.4 or ACI 318-11 D.9.2.4, as applicable.

Under the IBC, additional requirements as set forth in Section 1705.1.1 and Table 1705.3 of the 2015 or 2012 IBC, and Sections 1705, 1706 or 1707 of the 2009, 2006, and 2003 IBC must be observed, where applicable.

**4.4.2 Continuous Special Inspection:** Installations made under continuous special inspection with an on-site proof loading program must be performed in accordance with Section 1705.1.1 and Table 1705.3 of the 2015 and 2012 IBC, Sections 1704.4 and 1704.15 and Table 1704.4 of the 2009 IBC, or Section 1704.13 of the 2006 and 2003 IBC, whereby continuous special inspection is defined in Section 1702.1 of the IBC, and this report. The special inspector must be on the jobsite continuously during anchor installation to verify anchor type, adhesive expiration date, anchor dimensions, concrete type, concrete compressive strength, hole dimensions, hole cleaning procedures, anchor spacing, edge distances, concrete thickness, anchor embedment, tightening torque, and adherence to the manufacturers printed installation instructions.

The proof loading program must be established by the registered design professional. As a minimum, the following requirements must be addressed in the proof loading program:

1. Frequency of proof loading based on anchor type, diameter, and embedment.
2. Proof loads by anchor type, diameter, embedment, and location.
3. Acceptable displacements at proof load.
4. Remedial action in the event of a failure to achieve proof load, or excessive displacement.

Unless otherwise directed by the registered design professional, proof loads must be applied as confined tension tests. Proof load levels must not exceed the lesser of 67 percent of the load corresponding to the nominal bond strength as calculated from the characteristic bond stress for uncracked concrete modified for edge effects and concrete properties, or 80 percent of the minimum specified anchor element yield strength ($A_{se,N} \cdot f_{ya}$). The proof load shall be maintained at the required load level for a minimum of 10 seconds.

**4.4.3 Periodic Special Inspection:** Periodic special inspection must be performed where required in accordance with Section 1705.1.1 and Table 1705.3 of the 2015 and 2012 IBC, Section 1704.15 and Table 1704.4 of the 2009 IBC, or Section 1704.13 of the 2006, and 2003 IBC, whereby periodic special inspection is defined in Section 1702.1 of the IBC and this report. The special inspector must be on the jobsite initially during anchor installation to verify anchor type, anchor dimensions, concrete type, concrete compressive strength, hole dimensions, hole cleaning procedures, anchor spacing, edge distances, concrete thickness, anchor embedment, tightening torque, and adherence to the manufacturer's printed installation instructions. The special inspector must verify the initial installations of each type and size of adhesive anchor by construction personnel on the site. Subsequent installations of the same anchor type and size

by the same construction personnel are permitted to be performed in the absence of the special inspector. Any change in the anchor product being installed or the personnel performing the installation requires an initial inspection. For ongoing installations over an extended period, the special inspector must make regular inspections to confirm correct handling and installation of the product.

**4.5 Compliance with NSF/ANSI Standard 61:**

The Red Head C6+ Adhesive Anchoring System complies with the requirements of NSF/ANSI Standard 61, as referenced in Section 605 of the 2009 and 2006 *International Plumbing Code*® (IPC). Certified for use at a maximum surface area to volume ratio of 0.0005 square inches per liter in a tank. An NSF/ANSI Standard 61 listing is provided by NSF International.

## 5.0 CONDITIONS OF USE

The Red Head C6+ Adhesive Anchoring System described in this report complies with or is a suitable alternative to what is specified in, those codes listed in Section 1.0 of this report, subject to the following conditions:

**5.1** The Red Head C6+ Adhesive Anchoring System must be installed in accordance with the manufacturer's printed installation instructions, as included with the adhesive packaging and reproduced in Figure 3 of this report.

**5.2** The anchor system must be installed in cracked and uncracked normalweight concrete having a specified compressive strength of $f'_c$ = 2,500 psi to 8,500 psi (17.2 MPa to 58.6 MPa).

**5.3** The values of $f'_c$ used for calculation purposes must not exceed 8,000 psi (55 MPa).

**5.4** The concrete shall have attained its minimum design strength prior to installation of the anchor system.

**5.5** Anchors must be installed in concrete base materials in holes predrilled in accordance with the instructions provided in Figure 3 of this report, using a carbide-tipped masonry drill bit manufactured within the range of the maximum and minimum drill-tip dimensions of ANSI B212.15-1994, or a diamond core drill bit, as listed in Figure 3.

**5.6** Loads applied to the anchors must be adjusted in accordance with Section 1605.2 of the IBC for strength design and in accordance with Section 1605.3 of the IBC for allowable stress design.

**5.7** Red Head C6+ Adhesive Anchoring Systems are recognized for use in resisting short- and long-term loads, including wind and earthquake loads, subject to the conditions of this report.

**5.8** In structures assigned to Seismic Design Category C, D, E or F under the IBC or IRC, anchor strength must comply with the requirements of Section 4.1.11 of this report.

**5.9** Red Head C6+ Adhesive Anchoring Systems are permitted to be installed in concrete that is cracked or that may be expected to crack during the service life of the anchor, subject to the conditions of this report.

**5.10** Strength design values must be established in accordance with Section 4.1 of this report.

**5.11** Allowable stress design values must be established in accordance with Section 4.2 of this report.

**5.12** Minimum anchor spacing and edge distance, as well as minimum member thickness, must comply with the values given in this report.

**5.13** Prior to anchor installation, calculations and details demonstrating compliance with this report must be submitted to the code official. The calculations and details must be prepared by a registered design professional where required by the statutes of the jurisdiction in which the project is to be constructed.

**5.14** Anchors are not permitted to support fire-resistive construction. Where not otherwise prohibited by the code, anchors are permitted for installation in fire-resistive construction provided at least one of the following conditions is fulfilled:

- Anchors are used to resist wind or seismic forces only.
- Anchors that support gravity load–bearing structural elements are within a fire-resistive envelope or a fire-resistive membrane, are protected by approved fire-resistive materials, or have been evaluated for resistance to fire exposure in accordance with recognized standards.
- Anchors are used to support nonstructural elements.

**5.15** Since an ICC-ES acceptance criteria for evaluating data to determine the performance of adhesive anchors subjected to fatigue or shock loading is unavailable at this time, the use of these anchors under such conditions is beyond the scope of this report.

**5.16** Use of zinc-plated carbon steel threaded rods or steel reinforcing bars is limited to dry, interior locations.

**5.17** Use of hot-dipped galvanized carbon steel rods and stainless steel rods is permitted for exterior exposure or damp environments.

**5.18** Steel anchoring elements in contact with preservative-treated and fire-retardant-treated wood must be of zinc-coated carbon steel or stainless steel. The minimum coating weights for zinc-coated steel must comply with ASTM A153.

**5.19** Special inspection must be provided in accordance with Section 4.4 of this report. Continuous special inspection for anchors installed in horizontal or upwardly inclined orientations to resist sustained tension loads must be provided in accordance with Section 4.4 of this report.

**5.20** Installation of anchor systems in horizontal or upwardly inclined orientations to resist sustained tension loads shall be performed by personnel certified by an applicable certification program in accordance with ACI 318-14 17.8.2.2 or 17.8.2.3; or ACI 318-11 D.9.2.2 or D.9.2.3, as applicable.

**5.21** Red Head C6+ Adhesive Anchoring Systems may be used to resist tension and shear forces for floor (vertically down), wall (horizontal) and overhead installations with concrete temperatures between 50°F and 110°F. Horizontal and overhead applications are to be used with the $^3/_8$-inch- (9.5 mm) through $1^1/_4$-inch-diameter (31 mm) threaded rods and reinforcing bars. The adhesive must be injected directly to the back end of the hole using extension tubing (E916-6) for the ½-inch-diameter anchors, and extension tubing (E25-6) for the $^3/_8$-inch-diameter anchors. The $^5/_8$-inch- (16 mm) through $1^1/_4$-inch-

diameter (31 mm) threaded rod and reinforcing bars must be installed with a Red Head piston plug. See the MPII in Figure 3 of this report for temperature and installation requirements.

**5.22** The Red Head C6+ Adhesive Anchoring Systems may not be used for applications where the concrete temperature can rise from 40°F (or less) to 80°F (or higher) within a 12-hour period. Such applications may include but are not limited to anchorage of building facade systems and other applications subject to direct sun exposure.

**5.23** Red Head C6+ Adhesive is manufactured under a quality-control program with inspections by ICC-ES.

## 6.0 EVIDENCE SUBMITTED

Data in accordance with the ICC-ES Acceptance Criteria for Post-installed Adhesive Anchors in Concrete Elements (AC308), dated October 2016, which incorporates requirements in ACI 355.4-11.

## 7.0 IDENTIFICATION

Red Head C6+ Adhesive is identified by labels on the adhesive cartridges bearing the adhesive manufacturer's name (ITW Commercial Construction North America) and address (Glendale Heights, Illinois), the product name (Red Head C6+), best-used-by expiration date, and the evaluation report number (ESR-4046).

**FIGURE 1—RED HEAD C6+ ADHESIVE CARTRIDGES, DISPENSING TOOLS, MIXING NOZZLES, HOLE CLEANING BRUSHES AND HOLE PLUGS**

**TABLE 1—STEEL DESIGN INFORMATION FOR U.S. CUSTOMARY UNIT THREADED ROD [(1)]**

| CHARACTERISTIC | | SYMBOL | UNITS | NOMINAL ROD DIAMETER (inch) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $^3/_8$ | $^1/_2$ | $^5/_8$ | $^3/_4$ | $^7/_8$ | 1 | $1^1/_4$ |
| Threaded rod effective cross-sectional area | | $A_{se}$ | inch² | 0.078 | 0.142 | 0.226 | 0.335 | 0.462 | 0.606 | 0.969 |
| Carbon Steel A36 | Nominal steel strength in tension | $N_{sa}$ | lb | 4,500 | 8,230 | 13,110 | 19,400 | 26,780 | 35,130 | 56,210 |
| | Nominal steel strength in shear | $V_{sa}$ | lb | 2,700 | 4,940 | 7,870 | 11,640 | 16,070 | 21,080 | 33,730 |
| | Strength reduction factor for tension, steel failure mode | $\phi$ | - | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 |
| | Strength reduction factor for shear, steel failure mode[1] | $\phi$ | - | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 |
| | Reduction factor for seismic shear | $\alpha_{V,seis}$ | - | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 |
| Carbon Steel A193 B7 | Nominal steel strength in tension | $N_{sa}$ | lb | 9,690 | 17,740 | 28,250 | 41,810 | 57,710 | 75,710 | 121,140 |
| | Nominal steel strength in shear | $V_{sa}$ | lb | 5,810 | 10,640 | 16,950 | 25,090 | 34,630 | 45,430 | 72,680 |
| | Strength reduction factor for tension, steel failure mode | $\phi$ | - | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 |
| | Strength reduction factor for shear, steel failure mode[1] | $\phi$ | - | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 |
| | Reduction factor for seismic shear | $\alpha_{V,seis}$ | - | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 |
| Stainless Steel F593 | F593 CW1 nominal steel strength in tension | $N_{sa}$ | lb | 7,365 | 13,480 | 21,470 | - | - | - | - |
| | F593 CW1 nominal steel strength in shear | $V_{sa}$ | lb | 3,680 | 6,740 | 10,735 | - | - | - | - |
| | F593 CW2 nominal steel strength in tension | $N_{sa}$ | lb | - | - | - | 25,385 | 35,110 | 46,055 | 73,645 |
| | F593 CW2 nominal steel strength in shear | $V_{sa}$ | lb | - | - | - | 12,690 | 17,555 | 23,030 | 36,820 |
| | Strength reduction factor for tension, steel failure mode[1] | $\phi$ | - | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 |
| | Strength reduction factor for shear, steel failure mode | $\phi$ | - | 0.60 | 0.60 | 0.60 | 0.60 | 0.60 | 0.60 | 0.60 |
| | Reduction factor for seismic shear | $\alpha_{V,seis}$ | - | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 |

For **SI:** 1 inch = 25.4mm, 1 lbf = 4.45N, 1ft-lbf = 1.356 N-M, 1 psi = 0.006895 MPa.

[1]The tabulated value of $\phi$ applies when the load combinations of Section 1605.2 of the IBC, ACI 318-14 5.3 or ACI 318-11 9.2 are used. If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of $\phi$ must be determined in accordance with ACI 318-11 D.4.4.

**TABLE 2—CONCRETE BREAKOUT DESIGN INFORMATION FOR U.S. CUSTOMARY UNIT THREADED ROD [(1)]**

| CHARACTERISTIC | SYMBOL | UNITS | NOMINAL ROD DIAMETER (inch) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | $^3/_8$ | $^1/_2$ | $^5/_8$ | $^3/_4$ | $^7/_8$ | 1 | $1^1/_4$ |
| Effectiveness factor for uncracked concrete | $k_{uncr}$ | - | 24 | 24 | 24 | 24 | 24 | 24 | 24 |
| Effectiveness factor for cracked concrete | $k_{cr}$ | - | 17 | 17 | 17 | 17 | 17 | 17 | 17 |
| Minimum concrete thickness | $h_{min}$ | in. | $h_{ef} + 1^1/_4$ | | $h_{ef} + 2d_o$ | | | | |
| Anchor embedment depth - minimum | $h_{ef,min}$ | in. | $2^3/_8$ | $2^3/_4$ | $3^1/_8$ | $3^1/_2$ | $3^1/_2$ | 4 | 5 |
| Minimum spacing | $s_{min}$ | in. | $^{15}/_{16}$ | $1^1/_2$ | $2^1/_2$ | 3 | $3^1/_2$ | 4 | 5 |
| Minimum edge distance | $c_{min}$ | in. | $^{15}/_{16}$ | $1^1/_2$ | $2^1/_2$ | 3 | $3^1/_2$ | 4 | 5 |
| Critical edge distance | $c_{ac}$ | in. | See Section 4.1.10 of this report | | | | | | |
| Strength reduction factor for tension, concrete failure mode[1] | $\phi$ | Cond. B | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 |
| Strength reduction factor for shear, concrete failure mode[1] | $\phi$ | Cond. B | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 |

For **SI:** 1 inch = 25.4mm, 1 lbf = 4.45N, 1ft-lbf = 1.356 N-M, 1 psi = 0.006895 MPa.

[1]The tabulated value of $\phi$ applies when the load combinations of Section 1605.2 of the IBC, ACI 318-14 5.3 or ACI 318-11 9.2 are used and the requirements of ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable, for Condition B are met. If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of $\phi$ must be determined in accordance with ACI 318-11 D.4.4 for Condition B.

**TABLE 3—RED HEAD C6+ ADHESIVE ANCHOR BOND STRENGTH DESIGN INFORMATION FOR U.S. CUSTOMARY UNIT THREADED ROD INSTALLED IN HOLES DRILLED WITH A HAMMER DRILL AND CARBIDE BIT [1,5]**

| CHARACTERISTIC | | SYMBOL | UNITS | NOMINAL ROD DIAMETER (inch) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $^3/_8$ | $^1/_2$ | $^5/_8$ | $^3/_4$ | $^7/_8$ | 1 | $1^1/_4$ |
| Anchor embedment depth - minimum | | $h_{ef}$ | in. | $1^1/_2$ | 2 | $2^1/_2$ | 3 | $3^1/_2$ | 4 | 5 |
| Anchor embedment depth - maximum | | $h_{ef}$ | in. | $7^1/_2$ | 10 | $12^1/_2$ | 15 | $17^1/_2$ | 20 | 25 |
| Temperature Range A[2] | Characteristic Bond Strength for Uncracked Concrete | $T_{k,uncr}$ | psi | 2,470 | 2,390 | 2,315 | 2,240 | 2,160 | 2,085 | 1,930 |
| | Characteristic Bond Strength for Cracked Concrete | $T_{k,cr}$ | psi | 1,125 | 1,125 | 1,125 | 1,255 | 1,255 | 1,255 | 1,370 |
| Temperature Range B[3,4] | Characteristic Bond Strength for Uncracked Concrete | $T_{k,uncr}$ | psi | 2,110 | 2,040 | 1,975 | 1,910 | 1,845 | 1,780 | 1,645 |
| | Characteristic Bond Strength for Cracked Concrete | $T_{k,cr}$ | psi | 960 | 960 | 960 | 1,070 | 1,070 | 1,070 | 1,170 |
| Continuous Inspection | Strength Reduction Factor - Dry Concrete | $\phi_{dry,ci}$ | - | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 |
| | Strength Reduction Factor – Water-Saturated Concrete | $\phi_{sat,ci}$ | - | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 |
| | Strength Reduction Factor - Water-Filled Holes | $\phi_{wf,ci}$ | - | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 |
| | Strength Reduction Factor - Submerged Concrete | $\phi_{sub,ci}$ | - | 0.65 | 0.65 | 0.55 | 0.55 | 0.55 | 0.55 | 0.55 |
| Periodic Inspection | Strength Reduction Factor - Dry Concrete | $\phi_{dry,pi}$ | - | 0.65 | 0.65 | 0.65 | 0.55 | 0.55 | 0.55 | 0.55 |
| | Strength Reduction Factor – Water-Saturated Concrete | $\phi_{sat,pi}$ | - | 0.65 | 0.65 | 0.65 | 0.55 | 0.55 | 0.55 | 0.65 |
| | Strength Reduction Factor - Water-Filled Holes | $\phi_{wf,pi}$ | - | 0.55 | 0.55 | 0.55 | 0.55 | 0.55 | 0.55 | 0.55 |
| | Strength Reduction Factor - Submerged Concrete | $\phi_{sub,pi}$ | - | 0.55 | 0.65 | 0.55 | 0.45 | 0.45 | 0.45 | 0.45 |
| Submerged Installation Reduction Factor | | $\alpha_{N,sub}$ | - | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.81 | 1.00 |
| Reduction factor for seismic tension | | $\alpha_{N,seis}$ | - | 0.95 | 0.98 | 0.96 | 0.96 | 0.94 | 0.94 | 0.94 |

For **SI:** 1 inch = 25.4mm, 1 lbf = 4.45N, 1ft-lbf = 1.356 N-M, 1 psi = 0.006895 MPa.

[1]Bond strength values correspond to concrete compressive strengths ranging from 2,500 psi to 8,000.
[2]Temperature range A: Maximum short term temperature of 142°F and maximum long term temperature of 110°F.
[3]Temperature range B: Maximum short term temperature of 165°F and maximum long term temperature of 110°F.
[4]For load combinations consisting of only short-term loads, such as wind or seismic loads, bond strengths may be increased by 4 percent for Temperature Range B.
[5]For structures assigned to IBC or IRC Seismic Design Category C, D, E, or F, bond strength values must be multiplied by $\alpha_{N,seis}$.

**TABLE 4—RED HEAD C6+ ADHESIVE ANCHOR BOND STRENGTH DESIGN INFORMATION FOR U.S. CUSTOMARY UNIT THREADED ROD INSTALLED IN HOLES CORE DRILLED WITH A DIAMOND CORE BIT[1,5]**

| CHARACTERISTIC | | SYMBOL | UNITS | NOMINAL ROD DIAMETER (inch) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 3/8 | 1/2 | 5/8 | 3/4 | 7/8 | 1 | 1 1/4 |
| Anchor embedment depth - minimum | | $h_{ef}$ | in. | 1 1/2 | 2 | 2 1/2 | 3 | 3 1/2 | 4 | 5 |
| Anchor embedment depth - maximum | | $h_{ef}$ | in. | 7 1/2 | 10 | 12 1/2 | 15 | 17 1/2 | 20 | 25 |
| Temperature Range A[2] | Characteristic Bond Strength for Uncracked Concrete | $T_{k,uncr}$ | psi | 1,935 | 1,750 | 1,590 | 1,460 | 1,360 | 1,285 | 1,225 |
| | Characteristic Bond Strength for Cracked Concrete | $T_{k,cr}$ | psi | 1,010 | 1,010 | 1,010 | 1,030 | 975 | 965 | 1,030 |
| Temperature Range B[3,4] | Characteristic Bond Strength for Uncracked Concrete | $T_{k,uncr}$ | psi | 1,650 | 1,490 | 1,355 | 1,245 | 1,160 | 1,100 | 1,045 |
| | Characteristic Bond Strength for Cracked Concrete | $T_{k,cr}$ | psi | 860 | 860 | 860 | 880 | 835 | 825 | 880 |
| Continuous Inspection | Strength Reduction Factor - Dry Concrete | $\phi_{dry,ci}$ | - | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 |
| | Strength Reduction Factor – Water-Saturated Concrete | $\phi_{sat,ci}$ | - | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 |
| | Strength Reduction Factor - Water-Filled Holes | $\phi_{wf,ci}$ | - | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 |
| | Strength Reduction Factor - Submerged Concrete | $\phi_{sub,ci}$ | - | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 |
| Periodic Inspection | Strength Reduction Factor - Dry Concrete | $\phi_{dry,pi}$ | - | 0.65 | 0.65 | 0.65 | 0.55 | 0.55 | 0.55 | 0.65 |
| | Strength Reduction Factor – Water-Saturated Concrete | $\phi_{sat,pi}$ | - | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 |
| | Strength Reduction Factor - Water-Filled Holes | $\phi_{wf,pi}$ | - | 0.65 | 0.65 | 0.65 | 0.55 | 0.55 | 0.55 | 0.65 |
| | Strength Reduction Factor - Submerged Concrete | $\phi_{sub,pi}$ | - | 0.65 | 0.65 | 0.65 | 0.55 | 0.65 | 0.65 | 0.65 |
| Submerged Installation Reduction Factor | | $\alpha_{N,sub}$ | - | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Reduction factor for seismic tension | | $\alpha_{N,seis}$ | - | 0.95 | 0.98 | 0.96 | 0.96 | 0.94 | 0.94 | 0.94 |

For **SI:** 1 inch = 25.4mm, 1 lbf = 4.45N, 1ft-lbf = 1.356 N-M, 1 psi = 0.006895 MPa.

[1]Bond strength values correspond to concrete compressive strengths ranging from 2,500 psi to 8,000 psi.
[2]Temperature range A: Maximum short term temperature of 142°F and maximum long term temperature of 110°F.
[3]Temperature range B: Maximum short term temperature of 165°F and maximum long term temperature of 110°F.
[4]For load combinations consisting of only short-term loads, such as wind or seismic loads, bond strengths may be increased by 4 percent for Temperature Range B.
[5]For structures assigned to IBC or IRC Seismic Design Category C, D, E, or F, bond strength values must be multiplied by $\alpha_{N,seis}$.

**TABLE 5—STEEL DESIGN INFORMATION FOR U.S. CUSTOMARY UNIT REINFORCING BARS [1]**

| CHARACTERISTIC | | SYMBOL | UNITS | NOMINAL ROD DIAMETER (inch) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | **No. 3** | **No. 4** | **No. 5** | **No. 6** | **No. 7** | **No. 8** | **No. 9** | **No. 10** |
| Nominal bar diameter | | $d$ | in. | $^3/_8$ | $^1/_2$ | $^5/_8$ | $^3/_4$ | $^7/_8$ | 1 | $1^1/_8$ | $1^1/_4$ |
| Reinforcing bar effective cross-sectional area | | $A_{se}$ | inch² | 0.11 | 0.2 | 0.31 | 0.44 | 0.6 | 0.79 | 1.00 | 1.27 |
| **ASTM 615 Grade 60** | Nominal steel strength in tension | $N_{sa}$ | lb | 9,900 | 18,000 | 27,900 | 39,600 | 54,000 | 71,100 | 90,000 | 114,300 |
| | Nominal steel strength in shear | $V_{sa}$ | lb | 5,940 | 10,800 | 16,740 | 23,760 | 32,400 | 42,660 | 54,000 | 68,580 |
| | Strength reduction factor for tension, steel failure mode | $\phi$ | - | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 |
| | Strength reduction factor for shear, steel failure mode[1] | $\phi$ | - | 0.60 | 0.60 | 0.60 | 0.60 | 0.60 | 0.60 | 0.60 | 0.60 |
| | Reduction factor for seismic shear | $\alpha_{V,seis}$ | - | 0.91 | 0.91 | 0.91 | 0.90 | 0.90 | 0.71 | 0.71 | 0.71 |

For **SI:** 1 inch = 25.4mm, 1 lbf = 4.45N, 1ft-lbf = 1.356 N-M, 1 psi = 0.006895 MPa.

[1]The tabulated value of $\phi$ applies when the load combinations of Section 1605.2 of the IBC, ACI 318-14 5.3 or ACI 318-11 9.2 are used. If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of $\phi$ must be determined in accordance with ACI 318-11 D.4.4.

**TABLE 6—CONCRETE BREAKOUT DESIGN INFORMATION FOR U.S. CUSTOMARY UNIT REINFORCING BARS [1,2]**

| CHARACTERISTIC | SYMBOL | UNITS | NOMINAL ROD DIAMETER (inch) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | **No. 3** | **No. 4** | **No. 5** | **No. 6** | **No. 7** | **No. 8** | **No. 9** | **No. 10** |
| Effectiveness factor for uncracked concrete | $k_{uncr}$ | - | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 |
| Effectiveness factor for cracked concrete | $k_{cr}$ | - | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 |
| Minimum concrete thickness | $h_{min}$ | in. | $h_{ef} + 1^1/_4$ | | | $h_{ef} + 2d_o$ | | | | |
| Anchor embedment depth - minimum | $h_{ef,min}$ | in. | $2^3/_8$ | $2^3/_4$ | $3^1/_8$ | $3^1/_2$ | $3^1/_2$ | 4 | $4^1/_2$ | 5 |
| Minimum spacing | $s_{min}$ | in. | $^{15}/_{16}$ | $1^1/_2$ | $2^1/_2$ | 3 | $3^1/_2$ | 4 | $4^1/_2$ | 5 |
| Minimum edge distance | $c_{min}$ | in. | $^{15}/_{16}$ | $1^1/_2$ | $2^1/_2$ | 3 | $3^1/_2$ | 4 | $4^1/_2$ | 5 |
| Critical edge distance | $c_{ac}$ | in. | | See Section 4.1.10 of this report | | | | | | |
| Strength reduction factor for tension, concrete failure mode[1] | $\phi$ | Cond. B | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 |
| Strength reduction factor for shear, concrete failure mode[1] | $\phi$ | Cond. B | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 |

For **SI:** 1 inch = 25.4mm, 1 lbf = 4.45N, 1ft-lbf = 1.356 N-M, 1 psi = 0.006895 MPa.

[1]The tabulated value of $\phi$ applies when the load combinations of Section 1605.2 of the IBC, ACI 318-14 5.3 or ACI 318-11 9.2 are used and the requirements of ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable, for Condition B are met. If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of $\phi$ must be determined in accordance with ACI 318-11 D.4.4 for Condition B.
[2]The value of $f'_c$ used for calculation must be limited to maximum 8,000 psi (55 MPa) in accordance with ACI 318-14 17.2.7 or ACI 318-11 D.3.7, as applicable.

**TABLE 7—RED HEAD C6+ ADHESIVE ANCHOR BOND STRENGTH DESIGN INFORMATION FOR U.S. CUSTOMARY UNIT REINFORCING STEEL INSTALLED IN HOLES PREPARED WITH A HAMMER DRILL AND CARBIDE BIT [1,5]**

| CHARACTERISTIC | | SYMBOL | UNITS | NOMINAL ROD DIAMETER (inch) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | **No. 3** | **No. 4** | **No. 5** | **No. 6** | **No. 7** | **No. 8** | **No. 9** | **No. 10** |
| Anchor embedment depth - minimum | | $h_{ef}$ | in. | $1^1/_2$ | 2 | $2^1/_2$ | 3 | $3^1/_2$ | 4 | $4^1/_2$ | 5 |
| Anchor embedment depth - maximum | | $h_{ef}$ | in. | $7^1/_2$ | 10 | $12^1/_2$ | 15 | $17^1/_2$ | 20 | $22^1/_2$ | 25 |
| **Temperature Range A[2]** | Characteristic Bond Strength for Uncracked Concrete | $T_{k,uncr}$ | psi | 2,365 | 2,275 | 2,180 | 2,085 | 1,990 | 1,895 | 1,805 | 1,710 |
| | Characteristic Bond Strength for Cracked Concrete | $T_{k,cr}$ | psi | 1,125 | 1,125 | 1,110 | 1,190 | 1,140 | 1,090 | 1,040 | 1,080 |
| **Temperature Range B[3,4]** | Characteristic Bond Strength for Uncracked Concrete | $T_{k,uncr}$ | psi | 2,020 | 1,940 | 1,860 | 1,780 | 1,700 | 1,620 | 1,540 | 1,460 |
| | Characteristic Bond Strength for Cracked Concrete | $T_{k,cr}$ | psi | 960 | 960 | 945 | 1,015 | 975 | 930 | 890 | 925 |
| **Continuous Inspection** | Strength Reduction Factor - Dry Concrete | $\phi_{dry,ci}$ | - | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 |
| | Strength Reduction Factor – Water-Saturated Concrete | $\phi_{sat,ci}$ | - | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 |
| | Strength Reduction Factor - Water-Filled Holes | $\phi_{wf,ci}$ | - | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 |
| | Strength Reduction Factor - Submerged Concrete | $\phi_{sub,aci}$ | - | 0.65 | 0.65 | 0.65 | 0.55 | 0.55 | 0.55 | 0.55 | 0.55 |
| **Periodic Inspection** | Strength Reduction Factor - Dry Concrete | $\phi_{dry,pi}$ | - | 0.65 | 0.65 | 0.65 | 0.55 | 0.55 | 0.55 | 0.55 | 0.55 |
| | Strength Reduction Factor – Water-Saturated Concrete | $\phi_{sat,pi}$ | - | 0.65 | 0.65 | 0.65 | 0.55 | 0.55 | 0.55 | 0.55 | 0.65 |
| | Strength Reduction Factor - Water-Filled Holes | $\phi_{wf,pi}$ | - | 0.55 | 0.55 | 0.55 | 0.55 | 0.55 | 0.55 | 0.55 | 0.55 |
| | Strength Reduction Factor - Submerged Concrete | $\phi_{sub,pi}$ | - | 0.55 | 0.65 | 0.55 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 |
| Submerged Installation Reduction Factor | | $\alpha_{N,sub}$ | - | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.81 | 0.81 | 1.00 |
| Reduction factor for seismic tension | | $\alpha_{N,seis}$ | - | 0.88 | 0.88 | 0.88 | 0.84 | 0.84 | 0.84 | 0.84 | 0.95 |

For **SI:** 1 inch = 25.4mm, 1 lbf = 4.45N, 1ft-lbf = 1.356 N-M, 1 psi = 0.006895 MPa.

[1]Bond strength values correspond to concrete compressive strengths ranging from 2,500 psi to 8,000.
[2]Temperature range A: Maximum short term temperature of 142°F and maximum long term temperature of 110°F.
[3]Temperature range B: Maximum short term temperature of 165°F and maximum long term temperature of 110°F.
[4]For load combinations consisting of only short-term loads, such as wind or seismic loads, bond strengths may be increased by 4 percent for Temperature Range B.
[5]For structures assigned to IBC or IRC Seismic Design Category C, D, E, or F, bond strength values must be multiplied by $\alpha_{N,seis}$.

**TABLE 8—RED HEAD C6+ ADHESIVE ANCHOR BOND STRENGTH DESIGN INFORMATION FOR U.S. CUSTOMARY UNIT REINFORCING STEEL INSTALLED IN HOLES CORE DRILLED WITH A DIAMOND CORE BIT [1,5]**

| CHARACTERISTIC | | SYMBOL | UNITS | NOMINAL ROD DIAMETER (inch) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | **No. 3** | **No. 4** | **No. 5** | **No. 6** | **No. 7** | **No. 8** | **No. 9** | **No. 10** |
| Anchor embedment depth - minimum | | $h_{ef}$ | in. | $1^1/_2$ | 2 | $2^1/_2$ | 3 | $3^1/_2$ | 4 | $4^1/_2$ | 5 |
| Anchor embedment depth - maximum | | $h_{ef}$ | in. | $7^1/_2$ | 10 | $12^1/_2$ | 15 | $17^1/_2$ | 20 | $22^1/_2$ | 25 |
| **Temperature Range A[2]** | Characteristic Bond Strength for Uncracked Concrete | $T_{k,uncr}$ | psi | 1,855 | 1,660 | 1,495 | 1,360 | 1,255 | 1,170 | 1,145 | 1,085 |
| | Characteristic Bond Strength for Cracked Concrete | $T_{k,cr}$ | psi | 1,010 | 1,010 | 995 | 975 | 885 | 840 | 800 | 815 |
| **Temperature Range B[3,4]** | Characteristic Bond Strength for Uncracked Concrete | $T_{k,uncr}$ | psi | 1,585 | 1,420 | 1,280 | 1,160 | 1,070 | 1,000 | 980 | 930 |
| | Characteristic Bond Strength for Cracked Concrete | $T_{k,cr}$ | psi | 860 | 860 | 850 | 835 | 755 | 715 | 685 | 695 |
| **Continuous Inspection** | Strength Reduction Factor - Dry Concrete | $\phi_{dry,ci}$ | - | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 |
| | Strength Reduction Factor – Water-Saturated Concrete | $\phi_{sat,ci}$ | - | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 |
| | Strength Reduction Factor - Water-Filled Holes | $\phi_{wf,ci}$ | - | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 |
| | Strength Reduction Factor - Submerged Concrete | $\phi_{sub,aci}$ | - | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 |
| **Periodic Inspection** | Strength Reduction Factor - Dry Concrete | $\phi_{dry,pi}$ | - | 0.65 | 0.65 | 0.65 | 0.55 | 0.55 | 0.55 | 0.55 | 0.65 |
| | Strength Reduction Factor – Water-Saturated Concrete | $\phi_{sat,pi}$ | - | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 |
| | Strength Reduction Factor - Water-Filled Holes | $\phi_{wf,pi}$ | - | 0.65 | 0.65 | 0.65 | 0.55 | 0.55 | 0.55 | 0.55 | 0.65 |
| | Strength Reduction Factor - Submerged Concrete | $\phi_{sub,pi}$ | - | 0.65 | 0.65 | 0.65 | 0.55 | 0.65 | 0.65 | 0.65 | 0.65 |
| Submerged Installation Reduction Factor | | $\alpha_{N,sub}$ | - | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Reduction factor for seismic tension | | $\alpha_{N,seis}$ | - | 0.88 | 0.88 | 0.88 | 0.84 | 0.84 | 0.84 | 0.84 | 0.95 |

For **SI:** 1 inch = 25.4mm, 1 lbf = 4.45N, 1ft-lbf = 1.356 N-M, 1 psi = 0.006895 MPa.

[1]Bond strength values correspond to concrete compressive strengths ranging from 2,500 psi to 8,000 psi.
[2]Temperature range A: Maximum short term temperature of 142°F and maximum long term temperature of 110°F.
[3]Temperature range B: Maximum short term temperature of 165°F and maximum long term temperature of 110°F.
[4]For load combinations consisting of only short-term loads, such as wind or seismic loads, bond strengths may be increased by 4 percent for Temperature Range B.
[5]For structures assigned to IBC or IRC Seismic Design Category C, D, E, or F, bond strength values must be multiplied by $\alpha_{N,seis}$.

**TABLE 9—EXAMPLE RED HEAD C6+ ADHESIVE ALLOWABLE STRESS DESIGN VALUES (ASD) FOR ILLUSTRATIVE PURPOSES**

| Anchor Diameter (d) | Min/Max Embedment Depth, $h_{ef}$ (in) | Char. Bond Strength $\tau_{k,uncr}$ (psi) | Allowable Tension Load (lb) 2500psi- 8000psi | Controlling Failure Mode |
|---|---|---|---|---|
| $^3/_8$ | $2^3/_8$ | 2,470 | 1,929 | Concrete |
| | $7^1/_2$ | | 4,910 | Steel |
| $^1/_2$ | $2^3/_4$ | 2,390 | 2,403 | Concrete |
| | 10 | | 8,990 | Steel |
| $^5/_8$ | $3^1/_8$ | 2,315 | 2,911 | Concrete |
| | $12^1/_2$ | | 14,315 | Steel |
| $^3/_4$ | $3^1/_2$ | 2,240 | 3,451 | Concrete |
| | 15 | | 21,185 | Steel |
| $^7/_8$ | $3^1/_2$ | 2,160 | 3,451 | Concrete |
| | $17^1/_2$ | | 29,245 | Steel |
| 1 | 4 | 2,085 | 4,216 | Concrete |
| | 20 | | 38,365 | Steel |
| $1^1/_4$ | 5 | 1,930 | 5,892 | Concrete |
| | 25 | | 61,390 | Steel |

For **SI:** 1 inch = 25.4mm, 1 lbf = 4.45N, 1ft-lbf = 1.356 N-M, 1 psi = 0.006895 MPa.

This table was developed based on the following conditions:
[1]Single anchor with static tension only, A193 Grade B7 threaded rod
[2]Vertical downward installation direction
[3]Inspection regimen = Periodic
[4]Installation temperature = 50°F to 110°F
[5]Long term temperature = 110°F
[6]Short term temperature = 142°F
[7]Dry hole condition (carbide drilled hole)
[8]Embedment = hef (min/max for each diameter)
[9]Concrete determined to remain uncracked for the life of the anchorage
[10]Load combinations from ACI 318-11 Section 9.2 (no seismic loading)
[11]30% dead load and 70% live load, controlling load combination 1.2D + 1.6L
[12]Calculation of weighted average for α = 0.3*1.2 + 0.7*1.6 = 1.48
[13]$f'_c$ = 2,500 psi (normalweight concrete)
[14]$c_{a1} = c_{a2} \geq c_{ac}$
[15]$h \geq h_{min}$

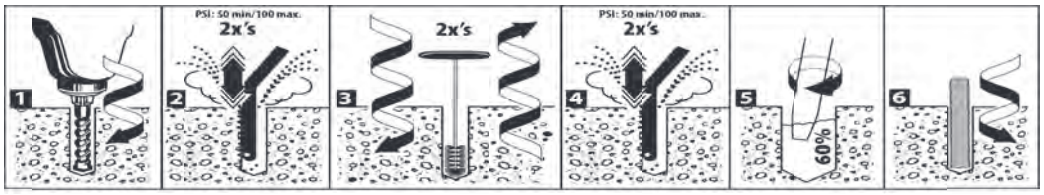
Illustrative Procedure to Calculate Allowable Stress Design Tension Value:
Red Head C6+ Adhesive Anchor $^1/_2$-inch diameter, using an embedment of $4^1/_2$ inches, assuming the conditions given in Table 9 (for use with the 2012 IBC, based on ACI 318-11 Appendix D). Applied tension load, $N_{ua}$ = 4,000 lbs.

| | PROCEDURE | CALCULATION |
|---|---|---|
| Step 1 | Calculate steel strength of a single anchor in tension per ACI 318-11 D.5.1.2 and Table 1 of this report. | $\phi N_{sa}$ = 0.75*17,740 = 13,305 lbs steel strength |
| Step 2 | Calculate concrete breakout strength of a single anchor in tension per ACI 318-11 D.5.2 and Table 2 of this report. | $N_b = k_{c,uncr} * \lambda_a \sqrt{f'_c}\ h_{ef}^{1.5}$ = 24* $\sqrt{2{,}500}$*4.5$^{1.5}$<br>$N_b$ = 11,455 lbs<br>$\phi N_{cb} = \phi A_{NC}/A_{NC0}\ \psi_{ed,N}\ \psi_{c,N}\ \psi_{cp,N}\ N_b$<br>$\phi N_{cb}$ = 0.65*1.0*1.0*1.0*1.0*11,455<br>$\phi N_{cb}$ = 7,446 lbs concrete breakout strength |
| Step 3 | Calculate bond strength of a single anchor in tension per ACI 318-11 D.5.5 and Table 3 of this report. | $N_{ba}$ = *$\lambda_a$ [illegible]<br>$N_{ba}$ = 1.0*2,390`*3.14*0.5*4.5<br>$N_{ba}$ = 16,885 lbs<br>$\phi N_a = \phi A_{Na}/A_{Na0}\ \psi_{ed,Na}\ \psi_{cp,Na}\ N_{ao}$<br>$\phi N_a$ = 0.65*1.0*1.0*1.0*16,885<br>$\phi N_a$ = 10,975 lbs bond strength |
| Step 4 | Determine compliance with required anchor strength per ACI 318-11 D.4.1. | $\phi N_{sa}$ = 13,305 lbs > $N_{ua}$ = 4,000 lbs<br>$\phi N_{cb}$ = 7,446 lbs > $N_{ua}$ = 4,000 lbs<br>$\phi N_a$ = 10,975 lbs > $N_{ua}$ = 4,000 lbs |
| Step 5 | Calculate allowable stress design conversion factor for loading condition per ACI 318-11 Section 9.2. | α = 1.2D + 1.6L = 1.2(0.3) + 1.6(0.7) = 1.48 |
| Step 6 | Calculate allowable stress design value per Section 4.2 of this report. | $T_{allowable,ASD} = \phi N_n / \alpha$ = 7,446 lbs/1.48<br>$T_{allowable,ASD}$ = 3,270 lbs allowable stress design |

FIGURE 2—EXAMPLE DESIGN CALCULATION

# RED HEAD C6+ ADHESIVE ANCHOR INSTALLATION INSTRUCTION

**Hammer Drilling Installation**




* Water-saturated concrete, water-filled holes and submerged concrete applications require 4x's air, 4x's brushing and 4x's air

1) ▪ Use a rotary hammer drill with a carbide drill bit complying to ANSI B212.15-1994 tolerance requirements or a core drill with diamond core bit. Drill hole to the required embedment depth. See attached table for drill bit specifications and min/maximum embedment depths.
▪ Installations may be used with maximum 1-1/4" diameter rods/rebar for floor, wall and overhead applications.
▪ Per construction specification, adhere to minimum spacing, minimum edge distance, and minimum member thickness.

2) ▪ For dry holes, oscillate a clean air nozzle in and out of the dry hole two times, for a total of two seconds, starting at the bottom of the hole with contaminant-free compressed air, exhausting hole until visually clean (i.e., no dust, debris, etc.)
▪ For water-saturated concrete and water-filled hole applications, oscillate a clean air nozzle in and out of the damp, water-filled or submerged hole four times, for a total of four seconds, starting at the bottom of the hole with contaminant-free compressed air, exhausting hole until visually clean (i.e., no dust, debris, etc.)
▪ If required, use an extension on the end of the air nozzle to reach the bottom of the hole.
▪ For core drilled holes, flush the hole twice with water, starting from the back of the hole using water line pressure.

3) ▪ Select an appropriately sized Red Head brush for the anchor diameter. Brush must be checked for wear before use. See attached table for brush specifications, including minimum diameter.
▪ Insert the brush into the hole with a clockwise motion. For every ½" forward advancement, complete one full turn until bottom of hole is reached. For faster and more suitable cleaning, attach the brush to a drill.
▪ Using a clockwise motion, for every full turn of the brush, pull the brush ½" out of the hole.
▪ For dry holes, twist/spin the brush two times in/out of the hole.
▪ For water-saturated concrete and water-filled hole applications, twist/spin the brush four times in/out of the hole.
▪ If required, use a wire brush extension (part nos. ESDS-38 or EHAN-38) to reach the bottom of the hole.
▪ Air clean the dust off the brush to prevent clogging of the brush.
▪ For core drilled holes, twist/spin the brush two times in/out of the hole.

4) ▪ For dry holes, oscillate a clean air nozzle in and out of the dry hole two times, for a total of two seconds, starting at the bottom of the hole with contaminant-free compressed air, exhausting hole until visually clean (i.e., no dust, debris, etc.)
▪ For water-saturated concrete and water-filled hole applications, oscillate a clean air nozzle in and out of the damp, water-filled or submerged hole four times, for a total of four seconds, starting at the bottom of the hole with contaminant-free compressed air, exhausting hole until visually clean (i.e., no dust, debris, etc.)
▪ For core drilled holes, flush the hole twice with water, starting from the back of the hole using water line pressure. Remove any remaining water in the hole using compressed air.

5) ▪ Review the Safety Data Sheet (SDS) before use.
▪ Check the "Use By" date on the cartridge and that the cartridge has been stored out of direct sunlight.
▪ Review the gel time/cure time chart, based on the temperature at time of installation, to determine tool, cartridge and nozzle requirements.
▪ Assemble the Red Head supplied cartridge and nozzle. Do not modify or remove mixing elements in nozzle.
▪ If nozzle does not reach the bottom of the hole, use Red Head E25-6 extension tubing (0.44" O.D.) positioned on the end of nozzle or use the S75EXT (nozzle extension) on the end of the S75 nozzle.
▪Place the assembly into a hand injection tool or a pneumatic injection tool.
▪ Dispense mixed adhesive outside of hole until uniform color is achieved.
▪ During installations, concrete must be between 50 and 110 degrees F, or artificially maintained.
▪ Insert the nozzle to the bottom of the hole and inject the adhesive at an angle, leaving the nozzle tip always slightly below the fill level.
▪ In a slow circular direction, work the adhesive into the sides of the hole, filling slowly to ensure proper adhesive distribution, until the hole is approximately 60% filled.
▪ For holes that contain water, keep injecting the adhesive below the water to displace the water upward.

***HORIZONTAL AND OVERHEAD INJECTION OF ADHESIVE:***
▪ For 3/8" and 1/2" diameter anchors installed horizontal and overhead, the adhesive may be injected directly to the back end of the hole using required Red Head E916-6 extension tubing (0.56" O.D.) for the ½" diameter anchors and Red Head E25-6 extension tubing (0.44" O.D.) for the 3/8" diameter anchors.

▪ For 5/8" diameter rod (#5 rebar) and larger anchors installed horizontal and overhead, assemble Red Head E916-6 extension tubing (0.56" O.D.) and appropriate sized piston plug on end of tubing:

PL-5834 for $^5/_8$" & ¾" diameter rod (No. 5 and No. 6 rebar)
PL-7810 for $^7/_8$" & 1" diameter rod (No. 7 and No. 8 rebar)
PL-1250 for 1-$^1/_4$" diameter rod (No. 9 and No. 10 rebar)

▪ The use of the Red Head pneumatic tool may be required for larger diameter anchor and/or deeper embedment installations at temperatures up to 110 degrees F.

6) ▪ Immediately insert the oil, rust and scale free rod/rebar assembly to the required embedment depth, using a counterclockwise motion to ensure proper adhesive distribution.
▪ The anchor rod/rebar must be marked with the required embedment depth.
▪ For wall (horizontal) and overhead installations with concrete or adhesive over 70 degrees F, the anchor rod/rebar must be marked with the required embedment depth and assembled with a Red Head hole plug positioned on the rod/rebar at the required embedment depth.
▪ After installing the anchor, the gap between the rod and the concrete must be completely filled with adhesive. The adhesive must fill voids, crevices and uniformly coat the rod and concrete.
▪ After installation, do not disturb the anchor until the full cure time has elapsed. Overhead installations must be supported until full cure time has elapsed.
▪ Adhesive must be fully cured before applying any load or torque. Do not over torque the anchor as this could adversely affect its performance.

**Core Drilling Installation**

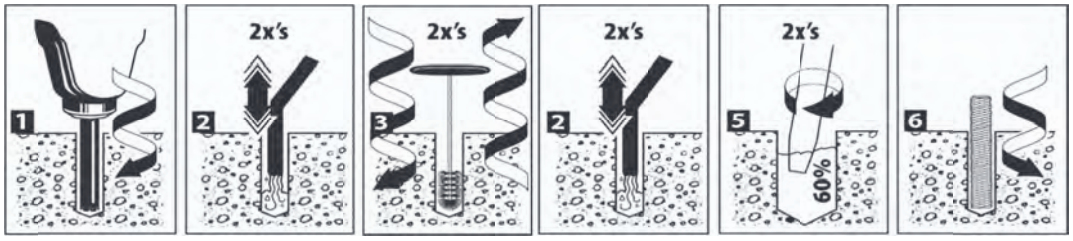



**FIGURE 3—RED HEAD C6+ ADHESIVE INSTALLATION INSTRUCTIONS**

**SPECIFICATIONS FOR INSTALLATION OF RED HEAD C6+ ADHESIVE ANCHORS IN CONCRETE**

**FOR INSTALLATION USING U.S. CUSTOMARY UNIT THREADED ROD**

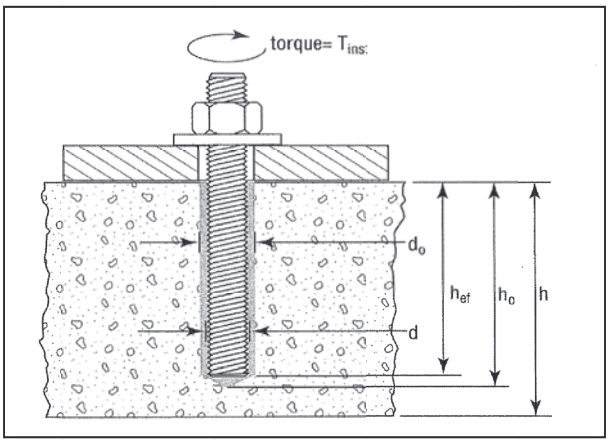
| CHARACTERISTIC | SYMBOL | UNITS | NOMINAL ROD DIAMETER (inch) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | $^3/_8$ | $^1/_2$ | $^5/_8$ | $^3/_4$ | $^7/_8$ | 1 | $1^1/_4$ |
| Nominal carbide bit/diamond core bit diameter | - | in. | $^7/_{16}$ | $^9/_{16}$ | $^3/_4$ | $^7/_8$ | 1 | $1^1/_8$ | $1^3/_8$ |
| Anchor embedment depth - minimum | $h_{ef,\,min}$ | in. | $2^3/_8$ | $2^3/_4$ | $3^1/_8$ | $3^1/_2$ | $3^1/_2$ | 4 | 5 |
| Anchor embedment depth - maximum | $h_{ef,\,max}$ | in. | $7^1/_2$ | 10 | $12^1/_2$ | 15 | $17^1/_2$ | 20 | 25 |
| Minimum spacing | $s_{min}$ | in. | $^{15}/_{16}$ | $1^1/_2$ | $2^1/_2$ | 3 | $3^1/_2$ | 4 | 5 |
| Minimum edge distance | $c_{min}$ | in. | $^{15}/_{16}$ | $1^1/_2$ | $2^1/_2$ | 3 | $3^1/_2$ | 4 | 5 |
| Minimum concrete thickness | $h_{min}$ | in. | $h_{ef} + 1^1/_4$ | | $h_{ef} + 2d_o$ | | | | |
| Maximum tightening torque for pretension clamping | $T_{inst}$ | ft lb | 9 | 16 | 47 | 70 | 90 | 110 | 370 |

**FOR INSTALLATION USING U.S. CUSTOMARY UNIT REINFORCING BARS**

| CHARACTERISTIC | SYMBOL | UNITS | NOMINAL REBAR DIAMETER (inch) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | No. 3 | No. 4 | No. 5 | No. 6 | No. 7 | No. 8 | No. 9 | No. 10 |
| Nominal carbide bit/diamond core bit diameter | - | in. | $^7/_{16}$ | $^5/_8$ | $^3/_4$ | $^7/_8$ | 1 | $1^1/_8$ | $1^1/_4$ | $1^3/_8$ |
| Anchor embedment depth - minimum | $h_{ef,\,min}$ | in. | $2^3/_8$ | $2^3/_4$ | $3^1/_8$ | $3^1/_2$ | $3^1/_2$ | 4 | $4^1/_2$ | 5 |
| Anchor embedment depth - maximum | $h_{ef,\,max}$ | in. | $7^1/_2$ | 10 | $12^1/_2$ | 15 | $17^1/_2$ | 20 | $22^1/_2$ | 25 |
| Minimum spacing | $s_{min}$ | in. | $^{15}/_{16}$ | $1^1/_2$ | $2^1/_2$ | 3 | $3^1/_2$ | 4 | $4^1/_2$ | 5 |
| Minimum edge distance | $c_{min}$ | in. | $^{15}/_{16}$ | $1^1/_2$ | $2^1/_2$ | 3 | $3^1/_2$ | 4 | $4^1/_2$ | 5 |
| Minimum concrete thickness | $h_{min}$ | in. | $h_{ef} + 1^1/_4$ | | | $h_{ef} + 2d_o$ | | | | |

For **SI:** 1 inch = 25.4mm, 1 lbf = 4.45N, 1ft-lbf = 1.356N-m, 1psi = 0.006895MPa.

**ANCHOR INSTALLATION**




**BRUSH, NOZZLE, EXTENSION TUBING AND PISTON PLUG SPECIFICATIONS**

| Anchor diameter (in) **(d)** | Brush Part No. | Minimum brush diameter (in) | Mixing nozzle | USE of extension tubing ONLY Part No | USE of Piston Plug with extension tubing Part Nos. |
|---|---|---|---|---|---|
| $^3/_8$ | WB038 | 0.563 | A24S or S55 | E25-6 | - |
| $^1/_2$ | WB012 | 0.675 | A24S or S55 | E25-6 | - |
| $^5/_8$ | WB058 | 0.900 | A24S or S55 | - | PL-5834 E916-6 |
| $^3/_4$ | WB034 | 1.125 | S55 or S75/S75EXT | - | PL-5834 E916-6 |
| $^7/_8$ | WB078 | 1.350 | S55 or S75/S75EXT | - | PL-7810 E916-6 |
| 1 & $1^1/_8$ | WB100 | 1.463 | S55 or S75/S75EXT | - | PL-7810 E916-6 |
| $1^1/_4$ | WB125 | 1.575 | S55 or S75/S75EXT | - | PL-1250 E916-6 |

**FIGURE 3—RED HEAD C6+ ADHESIVE INSTALLATION INSTRUCTIONS (Continued)**

**CURE TIMES AND GEL TIMES FOR RED HEAD C6+ ADHESIVE**

| Concrete Temperature (°F)[1] | Gel Time[2] | Cure Time[3] |
|---|---|---|
| 110 | 10 minutes | 2 hours |
| 90 | 14 minutes | 2.75 hours |
| 70 | 16 minutes | 6.5 hours |
| 50 | 30 minutes | 24 hours |

For **SI:** t° (°F-32) X .555 = °C.

[1]Adhesive must be installed in concrete temperatures within the noted range or artificially maintained at the noted temperature.
[2]Gel time is the maximum time from the end of mixing to when the insertion of the anchor into the adhesive must be completed and is based upon the adhesive and concrete temperatures noted.
[3]Cure time is the minimum time from the end of gel time to when the anchor maybe torque or loaded. Anchors are to be undisturbed during the cure time.

**FIGURE 3—RED HEAD C6+ ADHESIVE INSTALLATION INSTRUCTIONS (Continued)**

# ICC-ES Evaluation Report

# ESR-4046 FBC Supplement

Issued September 2017
This report is subject to renewal September 2018.

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DIVISION: 03 00 00—CONCRETE
Section: 03 16 00—Concrete Anchors

DIVISION: 05 00 00—METALS
Section: 05 05 19—Post-Installed Concrete Anchors

ITW RED HEAD
700 HIGH GROVE BOULEVARD
GLENDALE HEIGHTS, ILLINOIS 60139
(800) 848-5611
www.itw-redhead.com
techsupport@itwccna.com

EVALUATION SUBJECT:

ITW RED HEAD C6+ ADHESIVE ANCHORING SYSTEM FOR CRACKED AND UNCRACKED CONCRETE

## 1.0 REPORT PURPOSE AND SCOPE

Purpose:

The purpose of this evaluation report supplement is to indicate that Red Head C6+ Adhesive Anchoring System for Cracked and Uncracked Concrete, recognized in ICC-ES master evaluation report ESR-4046, has also been evaluated for compliance with the codes noted below.

Compliance with the following codes:

- 2014 Florida Building Code—Building
- 2014 Florida Building Code—Residential

## 2.0 PURPOSE OF THIS SUPPLEMENT

This supplement is issued to indicate that the Red Head C6+ Adhesive Anchoring System for Cracked and Uncracked Concrete described in Sections 2.0 through 7.0 of the master report, ESR-4046, complies with the Florida Building Code—Building and the Florida Building Code—Residential, when designed and installed in accordance with the 2012 International Building Code® (IBC) provisions noted in the master evaluation report under the following conditions:

- Design wind loads must be based on Section 1609 of the Florida Building Code—Building or Section 301.2.1.1 of the Florida Building Code—Residential, as applicable.
- Load combinations must be in accordance with Section 1605.2 or Section 1605.3 of the 2014 Florida Building Code—Building, as applicable.

Use of the Red Head C6+ Adhesive Anchoring System with stainless steel threaded rod materials has also been found to be in compliance with the High-Velocity Hurricane Zone provisions of the Florida Building Code—Building and the Florida Building Code—Residential when the following condition is met:

The design wind loads for use of the anchors in a High-Velocity Hurricane Zone are based on Section 1620 of the Florida Building Code—Building.

Use of the the Red Head C6+ Adhesive Anchoring System with carbon steel threaded rod materials and reinforcing bars for compliance with the High-velocity Hurricane Zone provisions of the Florida Building Code—Building and the Florida Building Code—Residential has not been evaluated and is outside the scope of this supplemental report.

For products falling under Florida Rule 9N-3, verification that the report holder's quality-assurance program is audited by a quality-assurance entity approved by the Florida Building Commission for the type of inspections being conducted is the responsibility of an approved validation entity (or the code official, when the report holder does not possess an approval by the Commission).

This supplement expires concurrently with the master report, issued September 2017.

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# ICC-ES Evaluation Report

# ESR-4109

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Issued 09/2017
This report is subject to renewal 09/2018.

**DIVISION: 04 00 00—MASONRY**
**SECTION: 04 05 19.16—MASONRY ANCHORS**

**REPORT HOLDER:**

## ITW RED HEAD

**700 HIGH GROVE BOULEVARD**
**GLENDALE HEIGHTS, ILLINOIS 60139**

**EVALUATION SUBJECT:**

## ITW RED HEAD C6+ ADHESIVE ANCHORING SYSTEM IN MASONRY

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# ICC-ES Evaluation Report

**ESR-4109**

Issued September 2017

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**DIVISION: 04 00 00—MASONRY**
**Section: 04 05 19.16—Masonry Anchors**

**REPORT HOLDER:**

**ITW RED HEAD**
**700 HIGH GROVE BOULEVARD**
**GLENDALE HEIGHTS, ILLINOIS 60139**
**(800) 848-5611**
**www.itw-redhead.com**
**techsupport@itwccna.com**

**EVALUATION SUBJECT:**

**ITW RED HEAD C6+ ADHESIVE ANCHORING SYSTEM IN MASONRY**

## 1.0 EVALUATION SCOPE

**Compliance with the following codes:**

- 2015, 2012, 2009 and 2006 International Building Code® (IBC)
- 2015, 2012, 2009 and 2006 International Residential Code® (IRC)

**Property evaluated:**

Structural

## 2.0 USES

The Red Head C6+ Adhesive Anchoring System is used to anchor building components to fully grouted concrete masonry walls to resist static, wind or seismic forces, as noted in Section 4.0 of this report.

The anchoring system is an alternative to Section 2.1.4 of TMS 402/ACI 530/ASCE 5 as referenced in Section 2107 of the IBC. The anchoring system may also be used where an engineered design is submitted in accordance with Section R301.1.3 of the IRC.

## 3.0 DESCRIPTION

### 3.1 General:

The Red Head C6+ Adhesive Anchoring System is available in dual-component cartridges, used with continuously threaded rods and deformed reinforcing bar. The primary components of the ITW Red Head C6+ Adhesive Anchoring System are shown in Figure 3 of this report.

The manufacturer's printed installation instructions (MPII) are included with the adhesive packaging and are replicated in Figure 4 of this report.

### 3.2 Materials:

**3.2.1 Red Head C6+ Adhesive:** The Red Head C6+ Anchoring System is a two-part epoxy packaged in a dual-chamber cartridge at a volumetric ratio of 2:1. The cartridge is available in either 30-ounce (side-by-side) or 15-ounce (side-by-side) sizes as shown in Figure 3. The components are dispensed through a static mixing nozzle which attaches to the cartridge. The original, unopened cartridge has a shelf life of 24 months, as indicated by the "best used by" date stamped onto the cartridge, when stored in a cool, dry, ventilated area.

**3.2.2 Hole Cleaning Equipment:** Hole cleaning equipment consists of wire brushes, as shown in Figures 3 and 4, and a compressed air nozzle with extension.

**3.2.3 Dispensing Tools:** Red Head C6+ Adhesive must be dispensed with manual or pneumatic dispensing tools provided by ITW Red Head, as shown in Figure 3.

**3.2.4 Anchor Elements:**

**3.2.4.1 Threaded Rods:** The continuously threaded rods range from $^3/_8$ inch through $^3/_4$ inches (9.5 mm through 19 mm) in diameter. Carbon steel threaded rods must comply with either ASTM A36 [minimum $f_{uta}$ = 58,000 psi (400 MPa)] or ASTM A193, Grade B7 [minimum $f_{uta}$ = 125,000 psi (860 MPa)]. Stainless steel threaded rods must comply with ASTM F593 (Alloy Type 300, CW1 and CW2) [minimum $f_{uta}$ = 95,000 psi (655 MPa) for CW1, and $f_{uta}$ =80,000 psi (552 MPa) for CW2]. Table 2 notes steel design information for the threaded rods. Carbon steel threaded rods must be furnished with a minimum 0.0002-inch-thick (5 μm) zinc electroplated coating complying with ASTM B633 SC1 or must be hot-dipped galvanized complying with ASTM A153, Class C or D. Threaded steel rods must be straight and free from indentations or other defects along their length.

**3.2.4.2 Steel Reinforcing Bars:** Steel reinforcing bars are deformed reinforcing bars as described in Table 5 of this report. The embedded portions of reinforcing bars must be straight, and free of mill scale, rust, mud, oil, and other coatings that may impair the bond with the adhesive.

**3.3 Grouted-filled Concrete Masonry:** The masonry shall be fully grouted complying with Chapter 21 of the IBC. The compressive strength of masonry, $f'_m$, at 28 days must be a minimum of 1,500 psi (13.1 MPa). Fully grouted masonry walls must be constructed from the following:

**3.3.1 Concrete Masonry Units (CMUs):** Concrete masonry walls must be constructed from minimum nominal 8-inch-wide (203 mm) by 8-inches-high (203 mm) by 16-inches-long (406 mm), lightweight, medium-weight or

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normal-weight concrete masonry units (CMUs) conforming to ASTM C90.

**3.3.2 Grout:** Grout-filled concrete masonry units must be fully grouted with grout complying with Section 2103.3 of the 2015 IBC, Section 2103.13 of the 2012 IBC, Section 2103.12 of the 2009 and 2006 IBC, Section R606.2.11 of the 2015 IRC, or Section R609.1.1 of the 2012, 2009 and 2006 IRC, as applicable. Alternatively, the grout must have a minimum compressive strength, when tested in accordance with ASTM C1019, equal to its specified strength, but not less than 2,000 psi (13.8 MPa).

**3.3.3 Mortar:** Mortar must be Types M, S or N prepared in accordance with Section 2103.2.1 of the 2015 IBC, 2103.9 of the 2012 IBC, Section 2103.8 of the 2009 and 2006 IBC, Section R606.2.7 of the 2015 IRC, or Section R607.1 of the 2012, 2009 and 2006 IRC, as applicable.

## 4.0 DESIGN AND INSTALLATION

### 4.1 Strength Design:

**4.1.1 General:** The design load values for anchors described in this report are based on allowable stress design (ASD), as an alternative to TMS 402/ACI 530/ASCE 5 Section 8.1.3 (2013 edition) or Section 2.1.4 (2011 or 2008 editions) as referenced in Section 2107.1 of the IBC. For use under the IRC, an engineered design in accordance with R301.1.3 must be submitted to the code official. Allowable tension and shear loads for installation in grout-filled masonry walls are noted in Tables 3, 4, 6 and 7 of this report. The allowable tension and shear values in this report must be adjusted in accordance with Figure 1 for in-service base material temperatures in excess of 70°F (21°C). Allowable tension and shear loads based on steel strength for threaded rods are described in Table 2. Allowable tension and shear loads based on steel strength for reinforcing bar are described in Table 5.

Allowable stress design tension and shear load values given in Tables 3, 4, 6 and 7 may be used to resist short-term loads such as wind as seismic, in accordance with Section 5.5 and Table 1 of this report. The allowable tension and shear loads are for anchors installed the area of the face of the grout-filled CMU wall (cell, web, bed joints, and head joints of walls constructed using open-ended blocks or head joint mortared full depth) and resisting static, wind or earthquake loads.

Critical and minimum spacing and edge distance values, with appropriate reduction values, where applicable, are given in Tables 3, 4, 6 and 7.

**4.1.2 Combined Loading:** The allowable loads for anchors installed in masonry and subjected to combined tension and shear forces must be determined by the following equation:

$$\left[\frac{P_s}{P_t}\right]^{5/3} + \left[\frac{V_s}{V_t}\right]^{5/3} \le 1$$

where:

$P_s$ = Applied service tension load (lbf or kN)

$P_t$ = Allowable service tension load (lbf or kN)

$V_s$ = Applied service shear load (lbf or kN)

$V_t$ = Allowable service shear load (lbf or kN)

### 4.2 Installation:

**4.2.1 General:** Anchors must be installed in accordance with this report and the manufacturer's printed installation instructions (MPII) represented in Figure 4. The anchors must not be installed until the base material has reached its minimum designated compressive strength. The drill bit size, hole diameter, embedment depth, spacing, edge distance and base material must comply with the requirements of this report. Installation procedures and locations must be in accordance with Tables 3, 4, 6 and 7 as well as Figure 2 of this report, as applicable.

**4.2.2 Installation in Grout-filled Concrete Masonry Wall:** Anchors are installed in grout-filled concrete masonry walls as specified in Tables 3, 4, 6 and 7. Installation requirements are tabulated for various threaded rod and rebar diameters in Figure 4. The minimum installation temperature is 50°F (10°C) for the adhesive and the masonry. Holes are drilled to predetermined depths using rotary hammer drills and carbide-tipped drill bits that comply with ANSI B212.15-1994. Holes must be cleaned from the back with compressed air and an air-nozzle extension. A wire brush is used to remove dust and debris from the hole, and this is followed by another cleaning with compressed air. A mixing nozzle is attached to the Red Head C6+ cartridge to ensure proper mixing of the adhesive from the dual-component system. Before application, the adhesive is pumped out of the nozzle until the material achieves a uniform dark-gray color. Holes may be dry or damp but must not contain any water at the time of installations. Holes are filled approximately 60% full with the mixed adhesive, and the threaded rods or reinforcement bars are inserted, with a rotating motion, to the back of the hole. The adhesive shall cure in accordance with Figure 4 before the placement of attachments.

### 4.3 Special Inspection:

Periodic special inspections are required in accordance with IBC Section 1704, and are also applicable for installations under the IRC.

The special inspector must be on the jobsite initially during anchor installation to verify anchor type, anchor dimensions, masonry type, masonry dimensions and compressive strength, drill bit size, anchor spacing, edge distances, embedment, and adherence to the manufacturer's printed installation instructions (MPII).

The special inspector must verify that the initial anchor installations of each type and size are in compliance with this evaluation report and in accordance with the MPII.

Subsequent installations of the same anchor type and size by the same construction personnel are permitted to be performed in the absence of the special inspector. Any change in the anchor product being installed or the personnel performing the installation requires an initial inspection. For ongoing installations over an extended period, the special inspector must make regular inspections to confirm correct handling and installation of the product.

## 5.0 CONDITIONS OF USE

The Red Head C6+ Adhesive Anchoring System described in this report complies with or is a suitable alternative to what is specified in, those codes listed in Section 1.0 of this report, subject to the following conditions:

**5.1** The Red Head C6+ Adhesive must be identified and installed in accordance with this report and the manufacturer's printed installation instructions (MPII), as included with the adhesive packaging and reproduced in Figure 4 of this report.

**5.2** Anchor sizes, dimensions, and minimum embedment depths are as set forth in this report.

**5.3** Red Head C6+ Adhesive Anchors described in Section 4.1.1 of this evaluation report are capable of resisting seismic and wind loads. When using the basic load combinations in accordance with IBC Section 1605.3.1, allowable loads must not be increased for wind or seismic loading. When using the alternative basic load combinations in 2009 and 2006 IBC Section 1605.3.2 that include seismic or wind loads, the allowable loads may be increased in accordance with Table 1, or the alternative basic load combinations may be decreased by the factors in Table 1, as applicable. For the 2015 and 2012 IBC, the allowable loads or load combinations must not be adjusted.

**5.4** Since an ICC-ES acceptance criteria for evaluating data to determine the performance of adhesive anchors subjected to fatigue and shock loading is unavailable at this time, the use of these anchors under these conditions is beyond the scope of this report.

**5.5** Prior to anchor installation, calculations and details demonstrating compliance with this report must be submitted to the code official. The calculations and details must be prepared by a registered design professional where required by the statutes of the jurisdiction in which the project is to be constructed.

**5.6** Anchors are not permitted to support fire-resistive construction. Where not otherwise prohibited by the code, anchors are permitted for installation in fire-resistive construction provided at least one of the following conditions is fulfilled:

- Anchors are used to resist wind or seismic forces only.
- Anchors that support gravity load–bearing structural elements are within a fire-resistive envelope or a fire-resistive membrane, are protected by approved fire-resistive materials, or have been evaluated for resistance to fire exposure in accordance with recognized standards.
- Anchors are used to support nonstructural elements.

**5.7** Since an ICC-ES acceptance criteria for evaluating data to determine the performance of adhesive anchors in cracked masonry is unavailable at this time, the use of adhesive anchors is limited to installation in uncracked masonry. Cracking occurs when $f_t > f_r$ due to service loads or deformations.

**5.8** The anchors may be installed in base materials having internal temperatures between 50°F (10°C) and 110°F (43°C) at the time of installation. Installation of Red Head C6+ adhesive in base materials having temperatures beyond this range is outside the scope of the report.

**5.9** When anchors are located where the internal base material temperature may exceed 70°F (21°C), allowable tension and shear loads indicated in this report must be adjusted for in-service temperatures in accordance with Figure 1. The use of Red Head C6+ adhesive in base materials having internal temperatures exceeding 176°F (80°C) during service life is beyond the scope of this report.

**5.10** Use of Red Head C6+ in conjunction with uncoated, or zinc electroplated carbon steel threaded rods must be limited to interior exposure. Use of stainless steel (AISI 304 or Type 316) anchors or hot-dipped galvanized anchors with zinc coating conforming to ASTM A153, Class C or D is permitted for exterior or damp environments.

**5.11** Special inspection in accordance with Section 4.3 of this report must be provided for all anchor installations.

**5.12** Red Head C6+ Adhesive is manufactured under a quality-control program with inspections by ICC-ES.

## 6.0 EVIDENCE SUBMITTED

**6.1** Data in accordance with the ICC-ES Acceptance Criteria for Adhesive Anchors in Masonry Elements (AC58), dated November 2015.

**6.2** A quality control manual.

## 7.0 IDENTIFICATION

Red Head C6+ Adhesive Anchors are identified by labels on the packaging indicating the manufacturer's name (ITW Commercial Construction North America) product name, material type, lot number traceable to production date, and the evaluation report number (ESR-4109).

**TABLE 1—ALTERNATIVE BASIC LOAD COMBINATION ADJUSTMENT FACTORS[1,2,3]**

| Steel Type | Modification Factors | | | |
|---|---|---|---|---|
| | Reductions for Alternate Basic Load Combinations | | Increase Factor for Allowable Loads for Short-term Loading Conditions | |
| | Tension | Shear | Tension | Shear |
| Standard threaded rods | 0.75 | 0.75 | 1.33 | 1.33 |
| High-strength rods | 0.75 | 1 | 1.33 | 1 |
| Stainless steel rods | 0.75 | 0.87 | 1.33 | 1.14 |
| Steel reinforcing bars | 0.75 | 0.75 | 1.33 | 1.33 |

[1]When using the basic load combinations in accordance with IBC Section 1605.3.1, allowable loads must not be increased for wind or seismic loading.
[2]The above modification factors are applicable under the 2009 or 2006 IBC only.
[3]When using the alternative basic load combinations in the 2009 or 2006 IBC Section 1605.3.2 that include wind or seismic loads, the allowable loads for anchors may be increased by the tabulated factors found in the right half of the table. Alternatively, the alternate basic load combinations may be reduced by multiplying them by the reduction factors found in the left half of the table. For example, for stainless steel rods in shear the alternate basic loads for wind or seismic may be multiplied by 0.87 for shear loading or divided by 1.14 (1/1.4 = 0.87), as applicable. For the 2015 and 2012 IBC, the allowable loads or load combination must not be adjusted.

**TABLE 2—ALLOWABLE TENSION AND SHEAR LOADS BASED ON STEEL DESIGN INFORMATION FOR U.S. CUSTOMARY UNIT THREADED ROD[1,2,3]**

| Anchor Diameter (inches) | Tension (lb) | | | Shear (lb) | | |
|---|---|---|---|---|---|---|
| | ASTM A307 $F_u$ = 60 ksi | ASTM A193 Grade B7 $F_u$ = 125 ksi | ASTM F593 SS 304 $F_u$ = 100 ksi | ASTM A307 $F_u$ = 60 ksi | ASTM A193 Grade B7 $F_u$ = 125 ksi | ASTM F593 SS 304 $F_u$ = 100 ksi |
| $^3/_8$ | 2,185 | 4,555 | 3,645 | 1,125 | 2,345 | 1,875 |
| $^1/_2$ | 3,885 | 8,100 | 6,480 | 2,000 | 4,170 | 3,335 |
| $^5/_8$ | 6,075 | 12,655 | 10,125 | 3,130 | 6,520 | 5,215 |
| $^3/_4$ | 8,750 | 18,225 | 12,390 | 4,505 | 9,390 | 6,385 |

For **SI:** 1 inch = 25.4mm, 1 lbf = 4.45N, 1ft-lbf = 1.356 N-M, 1 psi = 0.006895 MPa.

[1]Allowable load used in the design must be the lesser of bond values and tabulated steel element values.
[2]Allowable tension and shear loads for threaded rods to resist short term loads, such as wind or seismic, must be calculated in accordance with Section 4.1 as applicable.
[3]Allowable steel loads are based on allowable tension and shear stresses equal to 0.33X $F_u$ and 0.17x$F_u$, respectively.

**TABLE 3—ALLOWABLE RED HEAD C6+ ADHESIVE BOND TENSION LOADS FOR THREADED RODS INSTALLED INTO GROUT-FILLED CONCRETE MASONRY UNITS[1,2,3,4,7,9,10,11,12]**

| Threaded Rod Size | Minimum Embedment (inches) | Load at $s_{cr}$ and $c_{cr}$ (lb) | Spacing[5] | | | Edge Distance[6] | | |
|---|---|---|---|---|---|---|---|---|
| | | | Critical, $s_{cr}$ (inches) | Minimum, $s_{min}$ (inches) | Load reduction factor for $s_{min}$[8] | Critical, $c_{cr}$ (inches) | Minimum, $c_{min}$ (inches) | Load reduction factor for $c_{min}$[8] |
| $^3/_8$ | $3^3/_8$ | 945 | 13.5 | 4 | 1.00 | 12 | 4 | 0.87 |
| $^1/_2$ | $4^1/_2$ | 1,395 | 18 | 4 | 0.50 | 20 | 4 | 0.68 |
| $^5/_8$ | $5^5/_8$ | 1,825 | 22.5 | 4 | 0.50 | 20 | 4 | 0.68 |
| $^3/_4$ | $6^3/_4$ | 2,085 | 27 | 4 | 0.50 | 20 | 4 | 0.68 |

For **SI:** 1 inch = 25.4 mm; 1 lbf = 0.0044 kN, 1 ksi = 6.894 MPa. **(Refer to Table 4 for footnotes)**

**TABLE 4—ALLOWABLE RED HEAD C6+ ADHESIVE BOND SHEAR LOADS FOR THREADED RODS INSTALLED INTO GROUT-FILLED CONCRETE MASONRY UNITS[1,2,3,4,7,9,10,11,12]**

| Threaded Rod Size | Minimum Embedment (inches) | Load at $s_{cr}$ and $c_{cr}$ ⊥ to edge (lb) | Spacing[5] | | | Edge Distance[6] | | |
|---|---|---|---|---|---|---|---|---|
| | | | Critical, $s_{cr}$ (inches) | Minimum, $s_{min}$ (inches) | Load reduction factor for $s_{min}$[8] | Critical, $c_{cr}$ (inches) | Minimum, $c_{min}$ (inches) | Load reduction factor for $c_{min}$[8] |
| $^3/_8$ | $3^3/_8$ | 825 | 13.5 | 4 | 0.50 | 12 | 4 | 0.87 |
| $^1/_2$ | $4^1/_2$ | 1,560 | 18 | 4 | 0.50 | 20 | 4 | 0.56 |
| $^5/_8$ | $5^5/_8$ | 2,680 | 22.5 | 4 | 0.50 | 20 | 4 | 0.30 |
| $^3/_4$ | $6^3/_4$ | 3,180 | 27 | 4 | 0.50 | 20 | 4 | 0.27 |

For **SI:** 1 inch = 25.4 mm; 1 lbf = 0.0044 kN, 1 ksi = 6.894 MPa.

**(The following footnotes apply to both Tables 3 and 4)**

[1]All values are for anchors installed in fully grouted concrete masonry with minimum masonry strength of 1500 psi (10.3 MPa). Concrete masonry units must be light-, medium, or normal-weight conforming to ASTM C 90. Allowable loads have been calculated using a safety factor of 5.0.
[3]Anchors may be installed in any location in the face of the masonry wall (cell, web, bed joint) as shown in Figure 2.
[4]A maximum of two anchors may be installed in a single masonry cell in accordance with the spacing and edge or end distance requirements. Embedment is measured from the outside surface of the concrete masonry unit to the embedded end of the anchor. See Figure 2 of this report.
[5]The critical spacing distance, $s_{cr}$, is the anchor spacing where full load values in the table may be used. The minimum spacing distance, $s_{min}$, is the minimum anchor spacing for which values are available and installation is permitted. Spacing distance is measured from the centerline to centerline between two anchors.
[6]The critical edge or end distance, $c_{cr}$, is the distance where full load values in the table may be used. The minimum edge or end distance, $c_{min}$, is the minimum distance for which values are available and installation is permitted. Edge or end distance is measured from anchor centerline to the closest unrestrained edge.
[7]The tabulated values are applicable for anchors in the ends of grout-filled concrete masonry units where minimum edge distances are maintained.
[8]Load values for anchors installed less than $s_{cr}$ and $c_{cr}$ must be multiplied by the appropriate load reduction factor based on actual spacing (s) or edge distance (c). Load factors are multiplicative; both spacing and edge reduction factors must be considered.
[9]Linear interpolation of load values between minimum spacing ($s_{min}$) and critical spacing ($s_{cr}$) and between minimum edge or end distance ($c_{min}$) and critical edge or end distance ($c_{cr}$) is permitted.
[10]Concrete masonry width (wall thickness) must be equal to or greater than 1.5 times the anchor embedment depth (e.g. $^3/_8$-inch- and $^1/_2$-inch-diameter anchors are permitted in minimum nominally 6-inch-thick concrete masonry). The $^5/_8$- and $^3/_4$-inch-diameter anchors must be installed in minimum nominally 8-inch-thick concrete masonry.
[11]Allowable loads must be the lesser of the adjusted masonry or bond values tabulated above and the steel strength values given in Table 2.
[12]Tabulated allowable bond loads must be adjusted for increased in-service base material temperatures in accordance with Figure 1, as applicable.

**TABLE 5—ALLOWABLE TENSION AND SHEAR LOADS BASED ON STEEL STRENGTH FOR REINFORCING BARS[1,2,3]**

| Rebar Size | Tension (lb) | Shear (lb) |
|---|---|---|
| | ASTM A615, Grade 60 | ASTM A615, Grade 60 |
| No. 3 | 3,270 | 1,685 |
| No. 4 | 5,940 | 3,060 |
| No. 5 | 9,205 | 4,745 |
| No. 6 | 13,070 | 6,730 |

For **SI:** 1 inch = 25.4mm, 1 lbf = 4.45N, 1ft-lbf = 1.356 N-M, 1 psi = 0.006895 MPa.

[1]Allowable load used in the design must be the lesser of bond values and tabulated steel element values.
[2]Allowable tension and shear loads for threaded rods to resist short term loads, such as wind or seismic, must be calculated in accordance with Section 4.1 as applicable.
[3]Allowable steel loads are based on allowable tension and shear stresses equal to 0.33X $F_u$ and 0.17x$F_u$, respectively.

**TABLE 6—ALLOWABLE RED HEAD C6+ ADHESIVE BOND TENSION LOADS FOR REINFORCING BARS INSTALLED INTO GROUT-FILLED CONCRETE MASONRY UNITS[1,2,3,4,7,9,10,11,12]**

| Rebar Size | Minimum Embedment (inches) | Load at $s_{cr}$ and $c_{cr}$ (lb) | Spacing[5] | | | Edge Distance[6] | | |
|---|---|---|---|---|---|---|---|---|
| | | | Critical, $s_{cr}$ (inches) | Minimum, $s_{min}$ (inches) | Load reduction factor for $s_{min}$[8] | Critical, $c_{cr}$ (inches) | Minimum, $c_{min}$ (inches) | Load reduction factor for $c_{min}$[8] |
| No. 3 | $3^3/_8$ | 785 | 13.5 | 4 | 1.00 | 12 | 4 | 0.87 |
| No. 4 | $4^1/_2$ | 1,355 | 18 | 4 | 0.50 | 20 | 4 | 0.68 |
| No. 5 | $5^5/_8$ | 2,060 | 22.5 | 4 | 0.50 | 20 | 4 | 0.68 |
| No. 6 | $6^3/_4$ | 2,415 | 27 | 4 | 0.50 | 20 | 4 | 0.68 |

For **SI:** 1 inch = 25.4 mm; 1 lbf = 0.0044 kN, 1 ksi = 6.894 MPa. **(Refer to Table 7 for footnotes)**

**TABLE 7—ALLOWABLE RED HEAD C6+ ADHESIVE BOND SHEAR LOADS FOR REINFORCING BARS INSTALLED INTO GROUT-FILLED CONCRETE MASONRY UNITS[1,2,3,4,7,9,10,11,12]**

| Rebar Size | Minimum Embedment (inches) | Load at $s_{cr}$ and $c_{cr}$ ⊥ to edge (lb) | Spacing[5] | | | Edge Distance[6] | | |
|---|---|---|---|---|---|---|---|---|
| | | | Critical, $s_{cr}$ (inches) | Minimum, $s_{min}$ (inches) | Load reduction factor for $s_{min}$[8] | Critical, $c_{cr}$ (inches) | Minimum, $c_{min}$ (inches) | Load reduction factor for $c_{min}$[8] |
| No. 3 | $3^3/_8$ | 1,230 | 13.5 | 4 | 0.50 | 12 | 4 | 0.73 |
| No. 4 | $4^1/_2$ | 2,340 | 18 | 4 | 0.50 | 12 | 4 | 0.37 |
| No. 5 | $5^5/_8$ | 3,600 | 22.5 | 4 | 0.50 | 20 | 4 | 0.27 |
| No. 6 | $6^3/_4$ | 3,685 | 27 | 4 | 0.50 | 20 | 4 | 0.22 |

For **SI:** 1 inch = 25.4 mm; 1 lbf = 0.0044 kN, 1 ksi = 6.894 MPa.

**(The following footnotes apply to both Tables 6 and 7)**

[1]All values are for anchors installed in fully grouted concrete masonry with minimum masonry strength of 1500 psi (10.3 MPa). Concrete masonry units must be light-, medium, or normal-weight conforming to ASTM C 90. Allowable loads have been calculated using a safety factor of 5.0.
[3]Anchors may be installed in any location in the face of the masonry wall (cell, web, bed joint) as shown in figure 2.
[4]A maximum of two anchors may be installed in a single masonry cell in accordance with the spacing and edge or end distance requirements. Embedment is measured from the outside surface of the concrete masonry unit to the embedded end of the anchor. See Figure 2 of this report.
[5]The critical spacing distance, $s_{cr}$, is the anchor spacing where full load values in the table may be used. The minimum spacing distance, $s_{min}$, is the minimum anchor spacing for which values are available and installation is permitted. Spacing distance is measured from the centerline to centerline between two anchors.
[6]The critical edge or end distance, $c_{cr}$, is the distance where full load values in the table may be used. The minimum edge or end distance, $c_{min}$, is the minimum distance for which values are available and installation is permitted. Edge or end distance is measured from anchor centerline to the closest unrestrained edge.
[7]The tabulated values are applicable for anchors in the ends of grout-filled concrete masonry units where minimum edge distances are maintained.
[8]Load values for anchors installed less than $s_{cr}$ and $c_{cr}$ must be multiplied by the appropriate load reduction factor based on actual spacing (s) or edge distance (c). Load factors are multiplicative; both spacing and edge reduction factors must be considered.
[9]Linear interpolation of load values between minimum spacing ($s_{min}$) and critical spacing ($s_{cr}$) and between minimum edge or end distance ($c_{min}$) and critical edge or end distance ($c_{cr}$) is permitted.
[10]Concrete masonry width (wall thickness) must be equal to or greater than 1.5 times the anchor embedment depth (e.g. No. 3 and No. 4 reinforcing bars are permitted in minimum nominally 6-inch-thick concrete masonry). No. 5 and No. 6 reinforcing bars must be installed in minimum nominally 8-inch-thick concrete masonry.
[11]Allowable loads must be the lesser of the adjusted masonry or bond values tabulated above and the steel strength values given in Table 4.
[12]Tabulated allowable bond loads must be adjusted for increased in-service base material temperatures in accordance with Figure 1, as applicable.

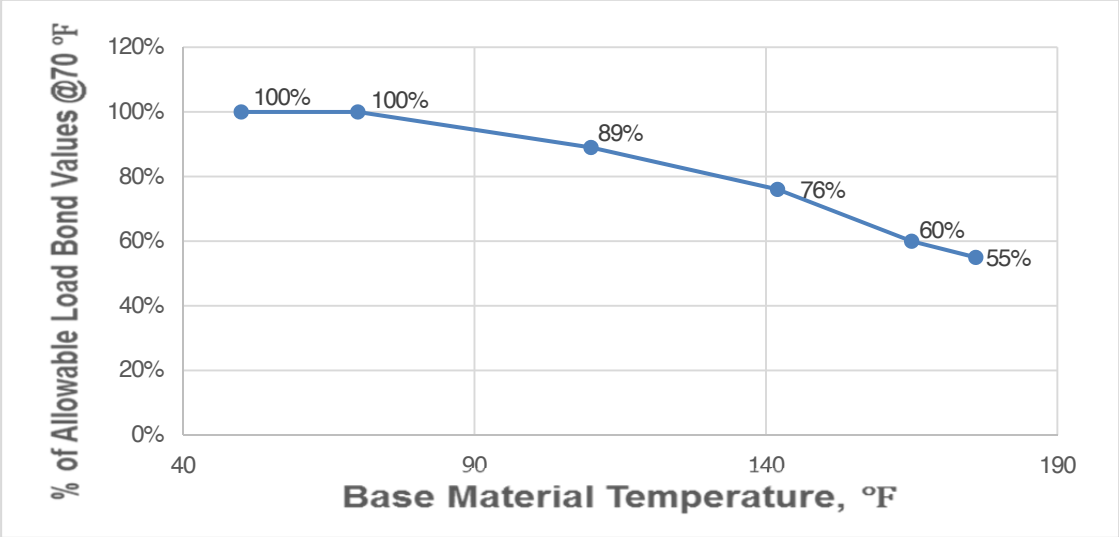



**FIGURE 1—INFLUENCE OF BASE MATERIAL TEMPERATURE ON ALLOWABLE ADHESIVE BOND TENSION AND SHEAR LOADS FOR RED HEAD C6+ ADHESIVE ANCHORS INSTALLED INTO THE FACE OF CONCRETE MASONRY UNIT WALLS**

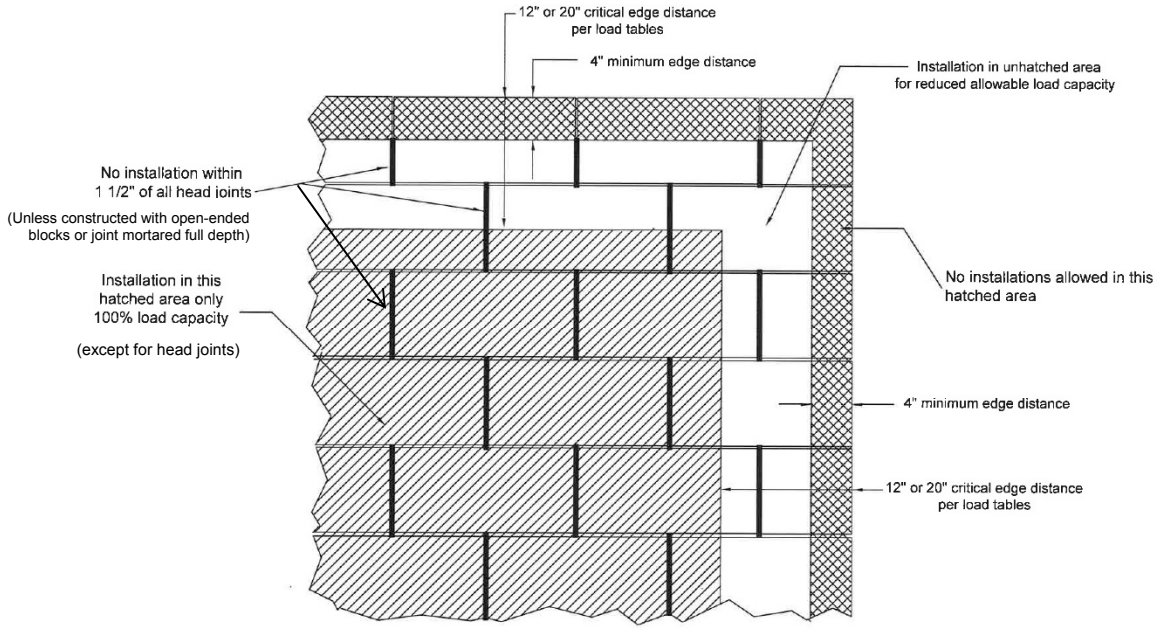



**FIGURE 2—ILLUSTRATION OF PERMISSABLE LOCATIONS FOR RED HEAD C6+ ADHESIVE ANCHORS INSTALLED INTO THE FACE OF GROUTED CONCRETE MASONRY WALL (ELEVATION VIEW)**

**FIGURE 3—RED HEAD C6+ ADHESIVE CARTRIDGES, DISPENSING TOOLS, MIXING NOZZLES, HOLE CLEANING BRUSHES AND HOLE PLUGS**

**SPECIFICATIONS FOR INSTALLATION OF RED HEAD C6+ ADHESIVE ANCHORS**

**BRUSH AND CARBIDE DRILL BIT SPECIFICATIONS**

| Anchor diameter (in) | Carbide drill bit diameter (in) | Brush Part No. | Minimum brush diameter (in) |
|---|---|---|---|
| $^3/_8$ No. 3 | $^7/_{16}$ | WB-038 | 0.563 |
| $^1/_2$ No. 4 | $^9/_{16}$ for threaded rod $^5/_8$ for rebar | WB-012 | 0.675 |
| $^5/_8$ No. 5 | $^3/_4$ | WB-058 | 0.900 |
| $^3/_4$ No. 6 | $^7/_8$ | WB-034 | 1.125 |

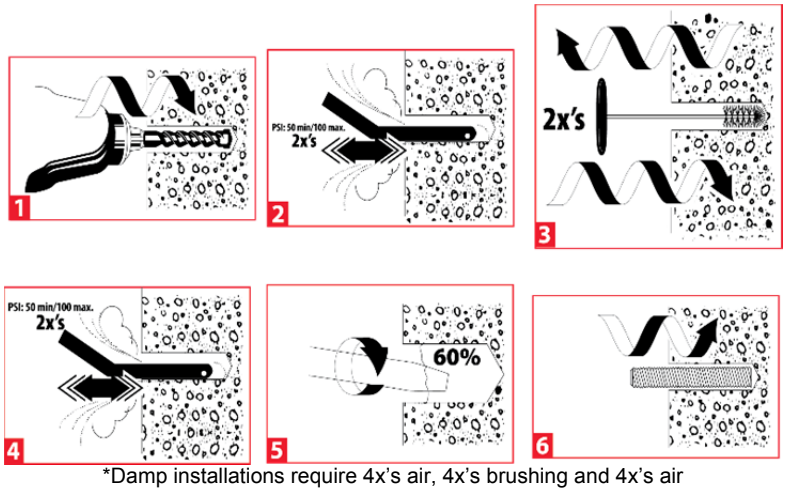
**CURE TIMES AND GEL TIMES FOR RED HEAD C6+ ADHESIVE**

| Concrete Temperature (°F)[1] | Gel Time[2] | Cure Time[3] |
|---|---|---|
| 110 | 10 minutes | 2 hours |
| 90 | 14 minutes | 2-$^3/_4$ hours |
| 70 | 16 minutes | 6-$^1/_2$ hours |
| 50 | 38 minutes | 24 hours |

For **SI:** t° (°F-32) X .555 = °C.

[1]Adhesive must be installed in concrete temperatures within the noted range or artificially maintained at the noted temperature.
[2]Gel time is the maximum time from the end of mixing to when the insertion of the anchor into the adhesive shall be completed and is based upon the adhesive and concrete temperatures noted.
[3]Cure time is the minimum time from the end of gel time to when the anchor maybe torque or loaded. Anchors are to be undisturbed during the cure time.

**FIGURE 4—RED HEAD C6+ ADHESIVE INSTALLATION INSTRUCTIONS**




*Damp installations require 4x's air, 4x's brushing and 4x's air

1) ▪ Use a rotary hammer drill with a carbide drill bit complying to ANSI B212.15-1994 tolerance requirements. Drill hole to the required embedment depth. See attached table for drill bit specifications and embedment depths.
▪ Installations may be used with maximum 3/4" diameter rods/rebar for masonry wall applications.
▪ Per construction specification, adhere to minimum spacing, minimum edge distance, and minimum wall thickness.

2) ▪ For dry holes, oscillate a clean air nozzle in and out of the dry hole two times, for a total of two seconds, starting at the bottom of the hole with contaminant-free compressed air, exhausting hole until visually clean (i.e., no dust, debris, etc.)
▪ For water-saturated applications, oscillate a clean air nozzle in and out of the damp hole four times, for a total of four seconds, starting at the bottom of the hole with contaminant-free compressed air, exhausting hole until visually clean (i.e., no dust, debris, etc.)
▪ If required, use an extension on the end of the air nozzle to reach the back of the hole.

3) ▪ Select an appropriately sized Red Head brush for the anchor diameter. Brush must be checked for wear before use. See attached table for brush specifications, including minimum diameter.
▪ Insert the brush into the hole with a clockwise motion. For every ½" forward advancement, complete one full turn until bottom of hole is reached. For faster and more suitable cleaning, attach the brush to a drill.
▪ Using a clockwise motion, for every full turn of the brush, pull the brush ½" out of the hole.
▪ For dry holes, twist/spin the brush two times in/out of the hole.
▪ For water-saturated applications, twist/spin the brush four times in/out of the hole.
▪ If required, use a wire brush extension (part nos. ESDS-38 or EHAN-38) to reach the bottom of the hole.
▪ Air clean the dust off the brush to prevent clogging of the brush.

4) ▪ For dry holes, oscillate a clean air nozzle in and out of the dry hole two times, for a total of two seconds, starting at the bottom of the hole with contaminant-free compressed air, exhausting hole until visually clean (i.e., no dust, debris, etc.)
▪ For water-saturated applications, oscillate a clean air nozzle in and out of the damp hole four times, for a total of four seconds, starting at the bottom of the hole with contaminant-free compressed air, exhausting hole until visually clean (i.e., no dust, debris, etc.)

5) ▪ Review the Safety Data Sheet (SDS) before use.
▪ Check the "Use By" date on the cartridge and that the cartridge has been stored in out of direct sunlight.
▪ Review the gel time/cure time chart, based on the temperature at time of installation, in order to determine tool, cartridge and nozzle requirements.
▪ Assemble the Red Head supplied cartridge and nozzle. Do not modify or remove mixing elements in nozzle.
▪Place the assembly into a hand injection tool or a pneumatic injection tool.
▪ Dispense mixed adhesive outside of hole until uniform color is achieved.
▪ During installations, masonry must be between 50 and 110 degrees F, or artificially maintained.
▪ Insert the nozzle to the bottom of the hole and inject the adhesive at an angle, leaving the nozzle tip always slightly below the fill level.
▪ In a slow circular direction, work the adhesive into the sides of the hole, filling slowly to ensure proper adhesive distribution, until the hole is approximately 60% filled.

6) ▪ Immediately insert the oil, rust and scale free rod/rebar assembly to the required embedment depth, using a counterclockwise motion to ensure proper adhesive distribution.
▪ The anchor rod/rebar must be marked with the required embedment depth.
▪ For installations with masonry or adhesive over 70 degrees F, the anchor rod/rebar must be marked with the required embedment depth and assembled with a Red Head hole plug positioned on the rod/rebar at the required embedment depth.
▪ After installing the anchor, the gap between the rod and the masonry must be completely filled with adhesive. The adhesive must fill voids, crevices and uniformly coat the rod and concrete.
▪ After installation, do not disturb the anchor until the full cure time has elapsed.
▪ Adhesive must be fully cured before applying any load or torque. Do not over torque the anchor as this could adversely affect its performance.

**FIGURE 4—RED HEAD C6+ ADHESIVE INSTALLATION INSTRUCTIONS (Continued)**

DIVISION: 04 00 00—MASONRY
Section: 04 05 19.16—Masonry Anchors

REPORT HOLDER:

ITW RED HEAD
700 HIGH GROVE BOULEVARD
GLENDALE HEIGHTS, ILLINOIS 60139
(800) 848-5611
www.itw-redhead.com
techsupport@itwccna.com

EVALUATION SUBJECT:

ITW RED HEAD C6+ ADHESIVE ANCHORING SYSTEM IN MASONRY

## 1.0 REPORT PURPOSE AND SCOPE

Purpose:

The purpose of this evaluation report supplement is to indicate that the RED HEAD C6+ Adhesive Anchoring System in Masonry, recognized in ICC-ES master evaluation report ESR-4109, has also been evaluated for compliance with the codes noted below.

Applicable code editions:

- 2014 Florida Building Code—Building
- 2014 Florida Building Code—Residential

## 2.0 CONCLUSIONS

The RED HEAD C6+ Adhesive Anchoring System in Masonry, described in Sections 2.0 through 7.0 of the master evaluation report ESR-4109, complies with the Florida Building Code—Building and the Florida Building Code—Residential, provided the design and installation are in accordance with the 2012 International Building Code® (IBC) provisions noted in the master report, and under the following conditions:

- Design wind loads must be based on Section 1609 of the Florida Building Code—Building or Section 301.2.1.1 of the Florida Building Code—Residential, as applicable.
- Load combinations must be in accordance with Section 1605.2 or Section 1605.3 of the Florida Building Code—Building, as applicable.

Use of the RED HEAD C6+ Adhesive Anchoring System with stainless steel threaded rod materials has also been found to be in compliance with the High-Velocity Hurricane Zone provisions of the Florida Building Code—Building and the Florida Building Code—Residential, when the following conditions are met:

- The design wind loads for use of the anchors in a High-Velocity Hurricane Zone are based on Section 1620 of the Florida Building Code—Building.

Use of RED HEAD C6+ Adhesive Anchoring System with carbon steel threaded rod materials for compliance with the High-velocity Hurricane Zone provisions of the Florida Building Code—Building and the Florida Building Code—Residential has not been evaluated, and is outside the scope of this supplemental report.

For products falling under Florida Rule 9N-3, verification that the report holder's quality-assurance program is audited by a quality-assurance entity approved by the Florida Building Commission for the type of inspections being conducted is the responsibility of an approved validation entity (or the code official, when the report holder does not possess an approval by the Commission).

This supplement expires concurrently with the master report, issued September 2017.

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